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De-Westernizing The Far East

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De - Westernizing The Far East

The Effects of Modernity on The Traditional Architecture of Yunnan, China

By Jericho Kakaio - Edwards

DE-WESTERNIING THE FAR EAST

BY JERICHO K. KAKAIO-EDWARDS

A thesis submitted in partial satisfaction of the requirements for the Honors in Architecture and Community Design program of the Department of Art + Architecture in the University of San Francisco’s College of Arts and Sciences.

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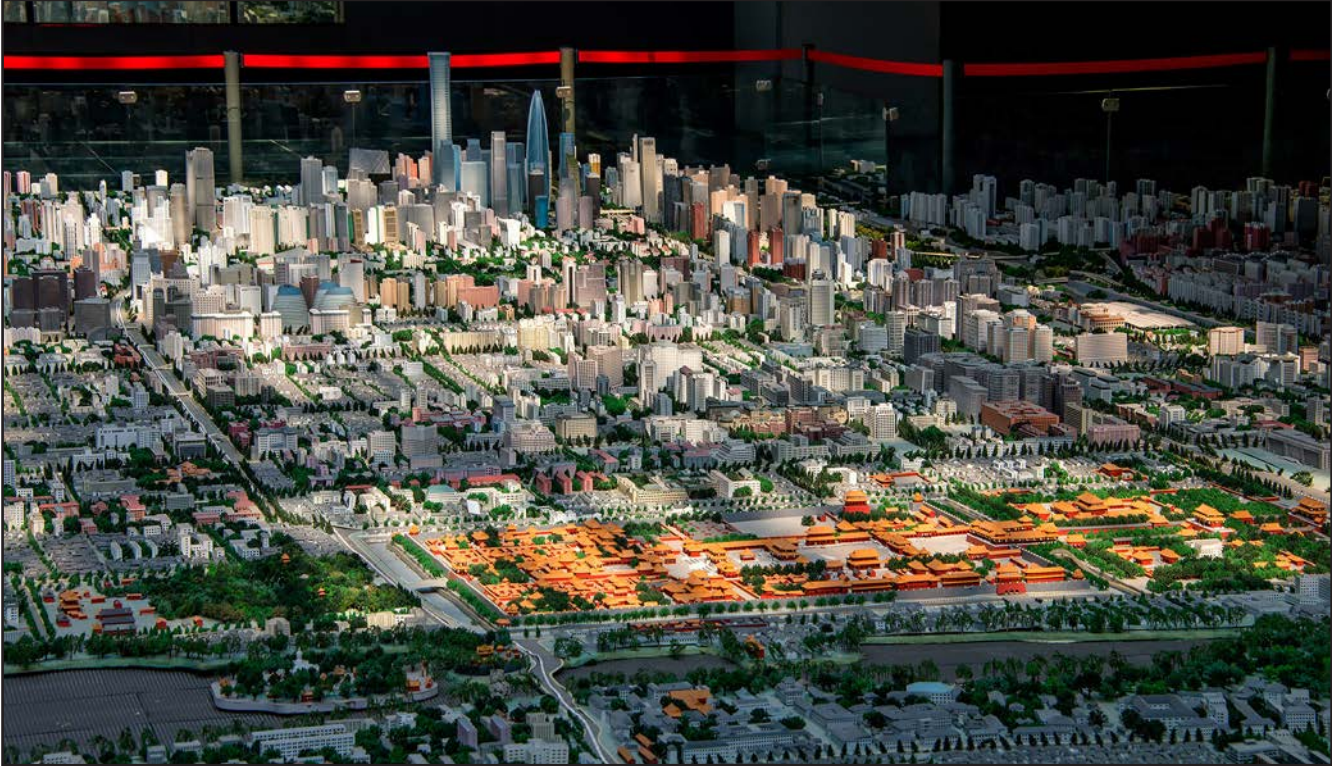
De-Westernizing The Far East

Isolated by the Tibetan highlands which frame Yunnan's northwest fringes, the ethnic minorities who call the region home live in rural settings ranging from rice-terraced fields to tropical forests; lifestyle unchanged for hundreds of years. However, with globalization causing an exposure to western standards of living, in conjunction with the country's predisposition towards all things foreign, the people of Yunnan have begun forgoing generations of vernacular architecture in favor of modern materials and regionally defunct construction methods. Here, we will seek to address this foible of architectural development by offering theoretical construction methods for housing types found throughout the region, successfully bridging the gap between regional practicality and modern amenity. The goal is to get away from uninformed mimicry, and offer alternative ways for the people of Yunnan to use modern materials, such that they enhance, rather than hinder, their vernacular architecture.

Yunnan Rice Terraces
By Tu Geo 2015



PROLOGUE EAST MEETS WEST



It was believed that all culture emanated from the Emperor; China the center of civilization the palace the center of China
Model of Beijing, Beijing Urban Planning Department. Photo by Jericho Kakaio-Edwards

The Idolizing of Foreign Goods

China’s foreign policy and its view towards outsiders has been altered throughout history almost as much as its view towards itself. Traditional China saw itself not as a nation-state, or even as an empire with clearly identified subjects, but as the center of civilization. In its eyes, other kingdoms and tribes were more or less civilized depending solely on how close they were to China culturally, politically, and geographically. Within this sphere of influence which would later be recognized as the Chinese territorial border, the empire reigned absolute from its core

provinces to rural areas like Yunnan.

For the most part, it viewed people outside these borders as uncivilized barbarians. This issue of arrogance eventually evolved into a tradition of belief that was no fault of the empire itself, but a natural occurrence given China’s uninterrupted centuries of domination over its neighbors. The result of this mentality was that when confronted with other civilizations of equal and perhaps greater technological or cultural achievements, these states were still viewed as less significant.

Therefore, when the Empire came into contact with the Western World, trading became an issue of supply and demand, for why would China desire anything from those it so definitively believed were inferior to itself?

As a result, China refused to trade for anything besides silver, which may have resulted in an influx of wealth and prosperity for the nation, but that grandeur was short lived. Weary of meeting the demand for Chinese goods through payments in silver, the British took steps to replace it with opium. In a few years, the

“The growing demand in Europe and America for Chinese teas, porcelain, and silks had not been matched by any Chinese demand for Western exports such as cotton, furs, or other mechanical curiosities such as clocks and weaponry”

-Jonathan D. Spence
The Search for Modern China 129

flow of silver shifted from the majority going into China to the majority leaving it. Opium soon became an epidemic addiction and Chinese officials were now faced with issues both domestic and foreign. Meanwhile, Europe’s mechanical advances were already ahead of their time, allowing them to easily defeat China in various wars over the years.

Substance abuse, continued unconditional defeat, a constant stream of western missionaries spreading Christianity into China’s very traditional society. The reform needed to ensure national survival proved too much for the waning Empire, and thus China’s long dynastic system crumbled under the weight of foreign influence.

The communist party of today was founded to address a civilization in discourse. Years of rebellion spurred on by the beliefs that the Empire could not compete with foreigners led to



British troops at the Battle of Amoy, 1841 First Opium War
Artist Michael Angelo Hayes

a political system founded on the idea that the old ways had failed them. The Cultural Revolution was essentially the destruction of China’s traditional values and the beginning of an idea that new is always better. However, in a nation which had just abandoned its tradition and by proxy its identity, the notion of “new” was a vague guide in otherwise uncharted territory.

Therefore China turned to a model which had proven itself superior to their tradition through military advancement alone: the west. The notion that

new is always better eventually evolved into foreign is always better, and has hence become a pivotal guide in modern Chinese society.

From Beijing’s architecture combining communist design and traditional Chinese motifs to Shanghai’s modern skyline, foreign influence has sculpted China in everything from its architecture to its pop culture. Finally in recent decades, for better or worse, that foreign idolizing train of thought has made its way to one of China’s furthest corners, to Yunnan.

This region in particular was selected due to its isolation and diversity. Separated from the rest of China by a mountainous landscape, the province was virtually inaccessible until the commercialization of modern air travel. Yet 25/55 of China's ethnic minority groups call the region home, forming a tapestry of variance both cultural and environmental. Yunnan extends from the Himalayas to Myanmar, giving it ecosystems ranging from alpine meadows to tropical forests, with vernacular architecture adapted to thrive in each environment.

Although there are 25 minorities present in the region, each with its own architectural style, this paper focuses on three: the Hani, Dai, and Tibetan people who live in mild, hot, and cold climates respectively. It is for this variation in climate that these groups were chosen.

The modern adaptation of traditional building typologies in all three cover a plethora of concerns which are fairly common to Yunnan as a whole. In addition, the range of climate and the issues that have resulted with the three building styles mean that although each group in Yunnan cannot be represented in this study, the construction methods may still overlap and be relevant outside the immediate three cultures. The Dai suffer from excess heat gain due to modern materials, the Tibetans the exact opposite with rapid heat loss, and the Hani people are experiencing lower seismic resistance in the earthquake prone province.

YUNNAN



REGIONAL OVERVIEW



Map of Yunnan and China, By betchartexpeditions.com

CLIMATE

Much of the province lies within the subtropical highland or humid subtropical zone, with mild to warm winters and tempered summers, except in the tropical south, where temperatures regularly exceed 86°F in the warmer half of the year. The plateau region has a relatively moderate climate. The western canyon region is hot and humid at the valley bottoms with freezing winds at the mountaintops. The average annual rainfall ranges from 24-91 in.

BIODIVERSITY

Yunnan is China’s most diverse province, both biologically and culturally. In summer, the Great Plateau of Tibet acts as a barrier to monsoon winds, trapping moisture in the province. This topographic range combined with a tropical moisture sustains extremely high biodiversity, often considered the richest botanically in the world’s temperate regions. Nearly 17,000 species of higher plants, can be found in the province.

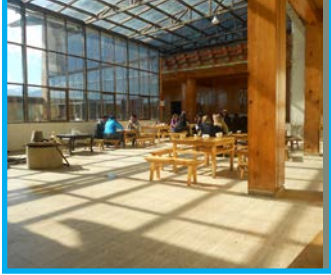
GEOGRAPHY

Yunnan is a province of the People’s Republic of China, located in the southwestern tip of the country. It spans approximately 394,000 sq km (152,000 sq mi) and has a population of 45.7 million. The province borders Vietnam, Laos and Burma. Yunnan is situated in a mountainous area, with high elevations in the northwest and low elevations in the southeast. Most of the population lives in the eastern part of the province. In the west, the altitude can vary from the mountain peaks to river valleys as much as 3,000 metres (9,800 ft).

“The province is said to have as much flowering plant diversity as the rest of the Northern Hemisphere put together.”

-David Paterson, former director of the Royal Botanic Garden in Edinburgh, Scotland

PEOPLES THE THREE CULTURES



HANI

Known for their rice terraces and building into hillsides, modern materials have spurred them into a transition from building seismically viable huts to homes greater in both size and lateral venerability.

DAI

Located in the tropics in a region untouched by winter, modern materials have allowed the homes to have a sense of opacity via modern windows, but have decreased functionality in terms of airflow and heat gain.

TIBETAN

Cold summers and frigid winters are the standard of the Tibetan plateaus. New materials have successfully allowed the homes provide shelter from the winds and heat themselves during the day, but that same heat is quickly lost as night falls.

PAST AND PRESENT

The Evolution of Tradition

This section explores the traditional architecture of the three cultures in question while providing background information on the people and life style of each. In doing so it will cover both the structural and aesthetic implication of these building typologies, highlighting not only how they work but why they were built this way. The focus will be on the aspects which were most influenced by the introduction of modern materials.

The section will then go into current methods of construction being implemented in each village today, in order to providing a contrast between past and present. The following forms a solid foundation for the proposed building methods to come by not only illustrating the environmental concerns of each location, but by also showing the ways in which new materials are hindering their architecture's ability to address them.

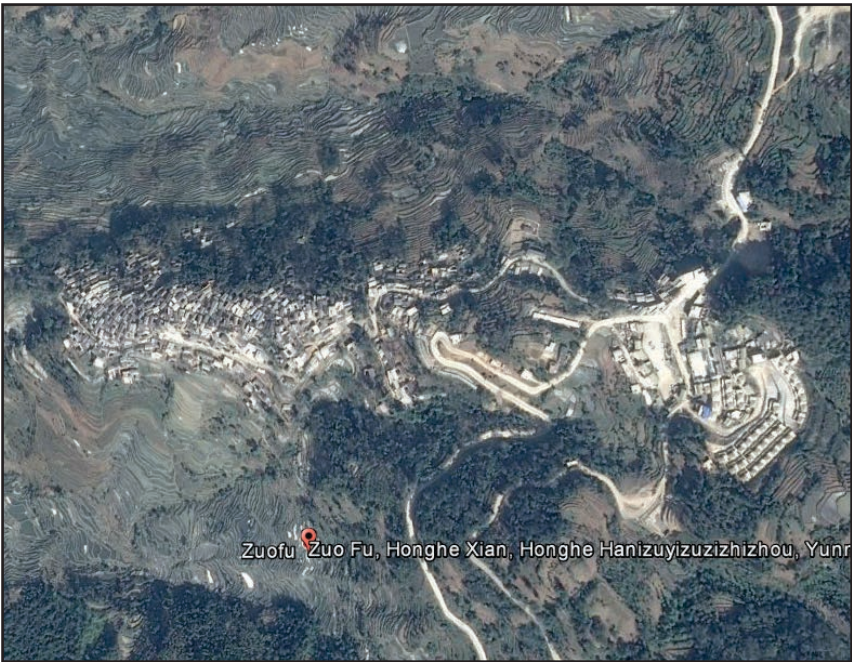
Life at Mushan Village
By Jericho Kakaio-Edwards 2015



HANI

Entering Zuofu Village
By Jericho Kakaio-Edwards 2015





Google Earth Pro

SITE LOCATION ZUOFU VILLAGE

“Hani” is an umbrella designation for a large number of groups. They are a subgroup of the trans-national ethnic group more commonly known as Akha, who as a whole reside in five countries: Burma, Laos, Vietnam, Thailand, and China. The estimated 1.75 million Hani located in southern Yunnan are mainly found along the banks of the Yuan or Mekong rivers between the Ailao and Mengle mountains.

The location of the Hani houses analyzed throughout this project is Zuofu village. The people of the Hani minority are known for nestling their houses into mountainsides which face the sun, and Zuofu Village is no exception. In terms of topography, Zuofu Village is situated on extremely steep hillsides both natural and man made. The Hani, aside from being known for embedding their homes into the mountains, are also famous for their rice terraces. These are essentially retaining walls constructed over hundreds of years which have formed their own unique ecosystem and altered the surrounding topology of the village. Due to the steepness of the land itself the Hani have adapted materials and construction methods which allow them to exist on these slopes even in a seismically charged region: 19 earthquakes in 2015 averaging 4.5 to 6 on the Richter Scale.

LOCATION

Zuofu Village is situated atop Ailao Mountain with an elevation of 6,000 ft. The village has a sub-tropical climate.

DEMOGRAPHIC

The population of Zuofu is roughly 1,500 people, most belonging to the Hani nationality and speaking the Hani dialect which has no written language; although some can understand Mandarin Chinese.

ECONOMY

The average annual income is approximately 2,000 RMB (300 USD). The village survives on agriculture focusing on rice, sugar cane, wheat, and potatoes. However fish are also cultivated in the rice terraces and various cuisines revolve around Yaks.

RELIGION

The villagers mostly follow the older notions of Polytheism and ancestor worship. The Hani often hold rituals to worship and appease family patron gods.



Yunnan Rice Terraces, By Tu Geo 2015

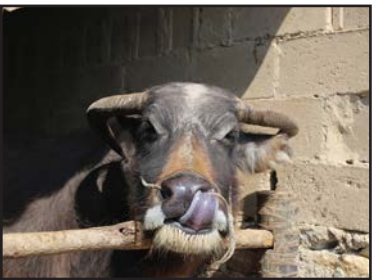
CONTACT WITH MODERNITY

Despite the growing popularity of Hani culture due to the rice terraces known worldwide, the Hani villages in Honghe County are among the least developed in Yunnan. This has allowed many cultural traditions to remain intact despite the flood of tourism often drawn to other

Hani villages. Honghe County attracts much less visitors than its neighbors due to very poor accessibility. Methods of accessing the village are currently limited to tour buses which must travel a minimum of several hours from the nearest civilization. Zuofu has recently



By Jericho Kakaio-Edwards
2015



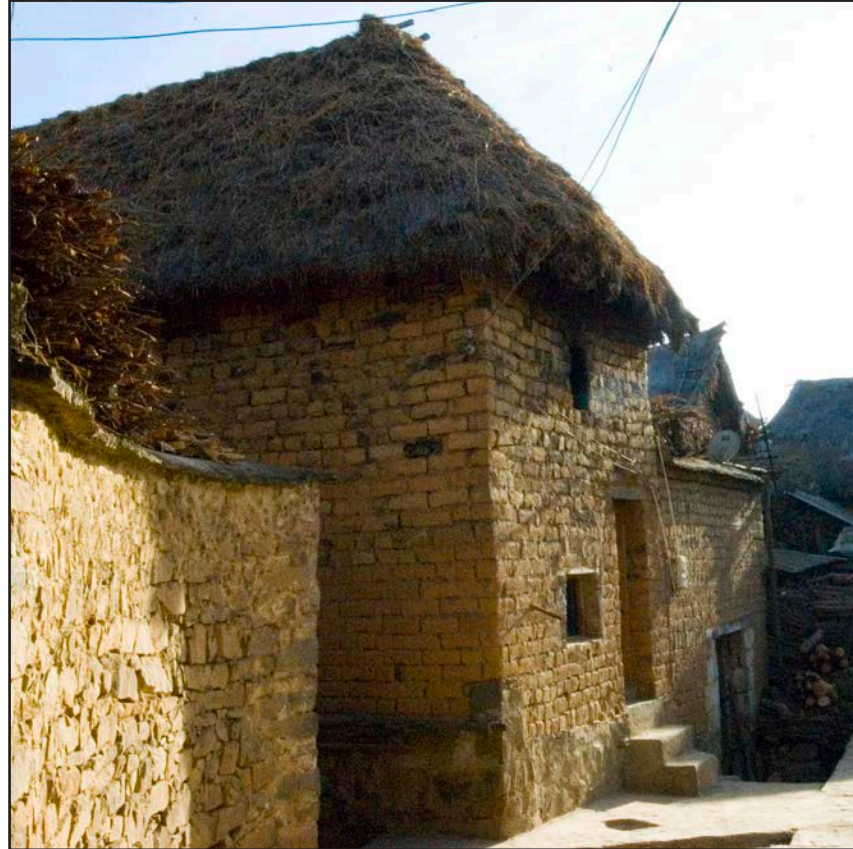
By Jericho Kakaio-Edwards
2015

been designated the reception village for visitors coming to Jiayin Township. However, an issue of limited funding combined with an inability to reach the site, still remain major obstacles in the area of tourism development.



Zuofu Village, By Jericho Kakaio-Edwards 2015

VERNACULAR ARCHITECTURE



Mud Brick Hani Home, By Eugene Geinzer 2013

GENERAL INFORMATION

Traditional Hani homes, as seen above, are comprised of mud brick, timber framing, and thatched roofs built onto a stone foundation.

Despite the apparent robustness of the masonry walls, you can see in the plan to the right that they are non-load bearing. The primary structure of the home remains the wooden post and beam system. Wood has more ductility than mud or masonry units, as such it has

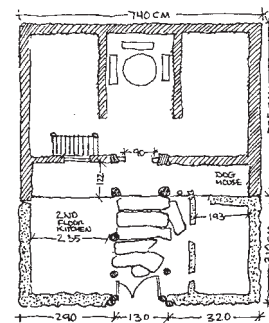
more seismic resilience given the geographic location and topography of Zuofu.

This type of construction allows the non-structural mud walls to collapse in the event of an earthquake in this seismically charged region, without jeopardizing the post and beam system and risking a roof cave in.

TOPOGRAPHIC

In terms of topography, Zuofu Village is situated on extremely steep hillsides both natural and man made. The Hani, famous for embedding their homes into the mountains, have had to be imaginative with how they design their homes and their utilization of space due to the steepness of the land itself as well as the plots taken up by agriculture.

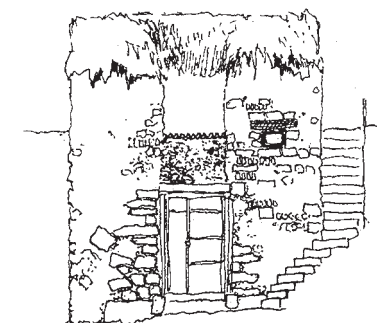
As such Hani houses are often organized very close together and multiple stories tall to optimize space.



Traditional Floor Plan
By Eugene Geinzer



Tiber framing and thatch roof at Zuofu Village, By Eugene Geinzer 2013



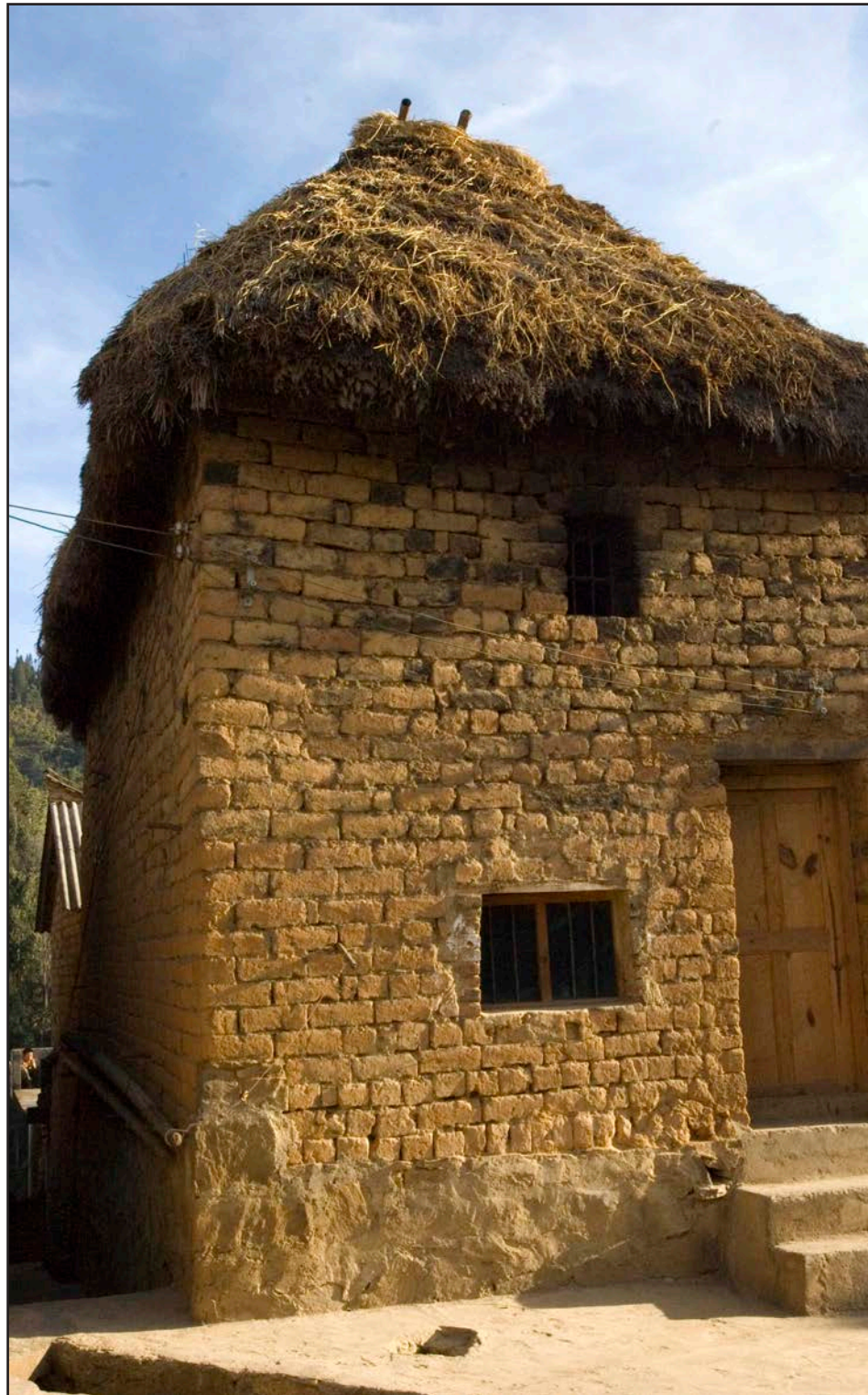
Traditional Elevation
By Eugene Geinzer

ROOF TYPES

Typically Hani houses had two different roof systems to choose from, which can even be combined on occasions. The first is a pointed “haystack like” roof which gives Hani architecture the nickname “mushroom houses.” The 2nd type is the flat roof. This type is preferred in areas with steep slopes because the space allows for the drying of grains.

ROOF STRUCTURE

The roofs are held up using a common framing system in which beams span the home with purlins resting on top of them. This forms a grid-like network of wood which can hold up the thatch roofing. Hani architecture then uses posts and beams to transfer the weight down to the foundation.



Traditional Hani Home
Zuofu Village
Eugene Geinzer 2013



Hani home with modern materials, By Jericho Kakaio-Edwards 2015

MODERN ADAPTATION

Today, the Hani people of Zuofu village have taken the primitive structures of their ancestors and infused them with traditional Confucian beliefs and modern materials. The houses which were typically miniscule and likely only one or two bays in size, have been expanded to the traditional Han number of three, likely due to the new found structural capabilities of concrete and brick. We see that the same roofing styles are still there as well as the sporadic layout of the villages themselves, yet in Zuofu we also find that the buildings are in the middle of a transitional phase by using modern materials to create classical Hani construction.

As seen in the house in the image above, the majority of the houses in Zuofu have replaced their wood and mud brick system with one of concrete and fired brick, not only allowing for larger homes to be made, but for a more modern aesthetic.

AESTHETIC

Many of the houses in the village are built three stories tall, larger than would be expected of a classic Hani home. The homes sometimes have a stucco finish and are organized into three jian, or bays, of which the center is the largest. This seems to be reminiscent of Chinese gates, in which the center portal of three was reserved for the emperor and therefor the most grand.

STRUCTURE

The modern adaptations of Hani architecture no longer use a post and beam structural system, instead, wooden beams are mounted directly into masonry load bearing walls. These walls are made up of fired brick with concrete columns distributed periodically throughout, although uncut masonry walls are often used in areas of the home pressed against hill sides to act as retaining walls. The uncut stones allow more surface area and a more stable wall. The entire structure sits on a concrete slab.

ISSUES

The new construction methods struggle with achieving seismic stability due to their over reliance on masonry. Brick and concrete form the main structural component in place of traditional, and more suitable, wooden system.

BUILDING MATERIALS

- Wood
- Fired Brick
- Mortar
- Concrete
- Masonry



Modern Hani Home at Zuofu Village, By Jericho Kakaio-Edwards 2015

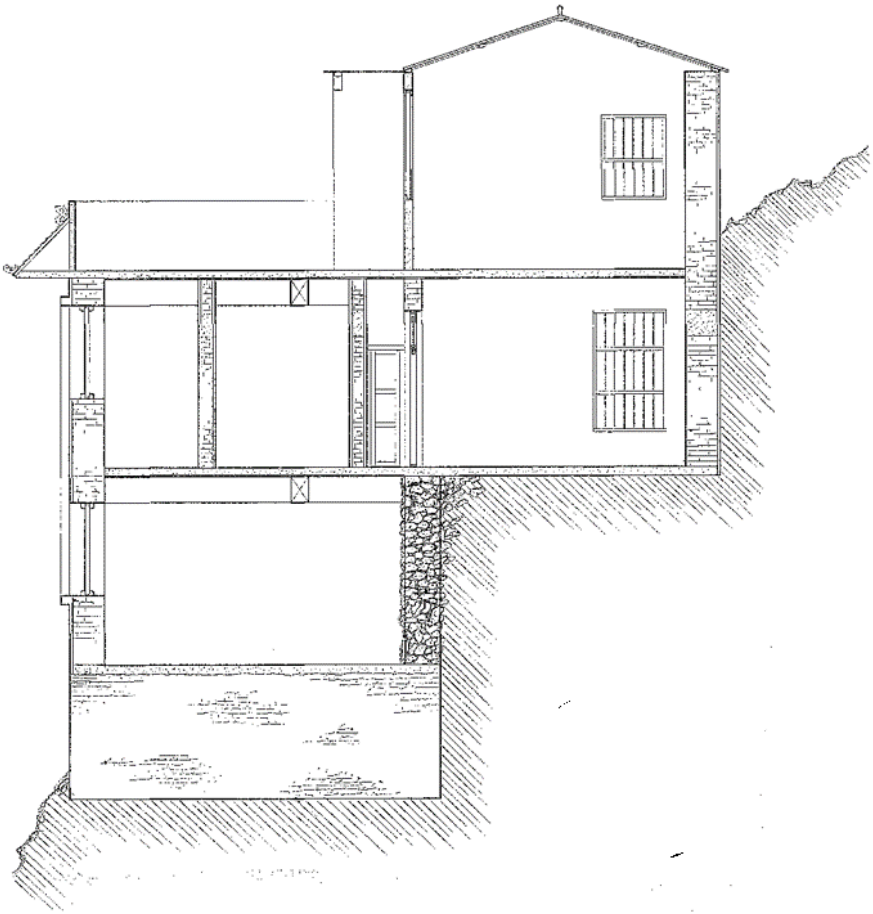


SEISMIC RESISTANCE
OR LACK THEREOF

As mentioned previously, the houses in Zuofu are made up of more modern materials than typical Hani construction would suggest. It appears that the bricks being used to form the majority of the home are no longer made up of mud brick, but the same type of fired bricks which can be found

at any western construction site. These bricks make up a load bearing system whereas traditional Hani houses used a post and beam system of wooden frames as their primary structure.

It is also important to note that while the majority of the home is comprised of brick with a stucco finish, all of the home is not. The roof, referring



to the higher “pitched” roof and not the flat deck, is made up of wooden beams running parallel to the section drawing above which hold up a composite steel sheet that is both the ceiling and roof. The right most wall of the first floor is made up of large stones, acting as one of the retaining walls mentioned in the “structural” section on page 18. The foundation slab appears to be made up of poured concrete, providing a solid base for a structure too heavy to sit on the soil of a

sloping hillside. However, what remains to be seen is if this load bearing masonry structure can hold up in an area as ravaged by earthquakes as Yunnan.

As evident in the section drawing above, this house in particular has no columns. While there are still wooden beams present, they run from one load bearing wall to the next and serve to hold up the heavier concrete floor slabs, and transfer that load directly into the masonry instead of



Hani Home: Side
By Jericho Kakaio 2015



Hani Home: Front
By Jericho Kakaio 2015

the timber columns found in traditional homes. The problem with this system is that wood is a more seismically viable material. As such, using wood as the main vertical support is a more reliable method than the masonry load bearing walls of Zuofu. In the traditional system, should the walls collapse in an earthquake, the wooden structure would still hold the floors and roofs firm. However, in this new version, the wooden beams, and everything that relies on them, connect directly into the wall. In an earthquake, this modern system means that when the walls fall, the rest of the home is left with no other support, and the whole thing will collapse.



Modern Hani home with fired brick between concrete columns, By Jericho Kakaio-Edwards 2015

“For the low-rise buildings, the reinforced concrete ring beams are placed at each floor and the postcast tie columns are placed at each intersections of interior and exterior masonry walls. Model experiments and engineering practices show that the concentrated masonry structures have a good strength, deformability, seismic reliability.”

-Dahai Liu, professor at Embry-Riddle Aeronautical University

However, although concrete columns dispersed periodically throughout individual masonry units can serve to strengthen the home and lessen lateral forces, that effect is greatly diminished when the concrete in question is not reinforced with rebar. Upon questioning the villagers of Zuofu, they testified that they do not have access to western reinforcing materials due to their isolation and the difficulty of transportation.

SUMMARY OF HANI THEN AND NOW



AESTHETIC

Simple hut like structures, also known as “mushroom houses,” have been adapted into much larger residences, with stucco finishes instead of the rough brick exterior of traditional homes.

ROOF STRUCTURE

Roofs have been converted from a system of thatch supported by timber framing to one of concrete slabs or corrugated steel, ultimately supported by masonry walls.

MATERIALS

Materials have evolved from mud brick and timber, to fired brick and concrete. Timber is still employed but no longer serves as a primary piece of vertical structure.

FUTURE - PAGE 49

The construction documents in the later sections, addressing the folly of modern Hani construction, will draw on various methods proven effective around the world from India to Chile. The section will attempt to combine the best aspects of various earth based construction techniques including mud brick and masonry. The goal is to develop a means of keeping the increased size and modern look of the new Hani homes, but regaining the seismic resilience of their traditional ancestors.

DAI

Modern home in Mengjinglai Village
By Jericho Kakaio-Edwards 2015





Google Earth Pro

SITE LOCATION MENGJINGLAI VILLAGE

The Dai people are Southeast Asian and culturally speaking quite similar to the Thai in Thailand. The estimated 1.15 million Dai are distributed along the Mekong River in Xishuangbanna in southern Yunnan, and in the drainage area of the Salween and Ruili rivers in western Yunnan. In both areas the Dai are valley-dwelling paddy growers.

The setting addressing the modernization of Dai construction will be situated in Mengjinglai Village. Located near the eastern end of the Sino-Myanmar border, the village is situated on a basin next to Daluo River which separates China and Myanmar (Burma). Due a lower altitude than most other portions of Yunnan, Xishuangbanna is a place without winter with an average monthly temperature of 82 F or 28 C. The village has a strict building code to ensure a traditional Dai aesthetic, yet this code does not extend to materials and functionality. As such, the village serves as an interesting example of how modern technology can mimic the visuals of traditional architecture while failing to harmonize with it and undermining its ultimate design intension.

LOCATION

Mengjinglai village is situated on a basin next to the Daluo River which separates China and Myanmar. Due to its location at the country’s southern most region it enjoy a tropical climate.

DEMOGRAPHIC

The population of Mengjinglai is roughly 500 people, most belonging to the Tai Lu or Shui sect of the Dai nationality. Villagers speak the Dai language although most understand Mandarin Chinese.

ECONOMY

The average annual income is approximately 4,000 RMB (620 USD). The village focuses primarily on rice farming and banana or rubber tree plantations. However the village has recently become a prominent tourist destination, providing jobs for many villages choosing to offer room and board.

RELIGION

The villagers follow Theravada Buddhism. Young men often live in the village temple for several years to learn Buddhism and Dai scripts. They are then given the option to become monks but most return to secular life.



Life in Mengjinglai, By Jericho Kakaio-Edwards 2015



By Jericho Kakaio-Edwards
2015



By Jericho Kakaio-Edwards
2015

CONTACT WITH MODERNITY

Mengjinglai considers itself to be an excellent example of the balance of indigenous cultural conservation and the rapid boom in village development because of tourism. As shown bellow, the village keeps the aesthetic of traditional Dai homes, which are built onto

level embankments and face rivers or lakes. They are always raised above potential flood risks by stilts cut from lumbar in the surrounding area. However this harmony, even though mostly aesthetic, is dependent on the village’s small number of visitors per year. Being on the

borderlands between China and Myanmar, political turmoil limits desire to come to the region. It remains to be seen whether the simple village life would be able to survive a wave of large scale tourism should issues with the boarder entry point subside.



Entering Mengjinglai Village, By Jericho Kakaio-Edwards 2015

VERNACULAR ARCHITECTURE



Dai replica at Beijing's Chinese Ethnic Culture Park, By Jericho Kakaio-Edwards 2015

GENERAL INFORMATION

When the ancestors of Xishuangbanna's Dai people first migrated to Yunnan over two millennia ago, they discovered lush valleys which were ideal places to grow the kind of rice essential to their way of living. So the new settlers selected sites near rivers or streams and started building the kind of houses that they were known for back in their original southeast China homeland.

The model was the stilted

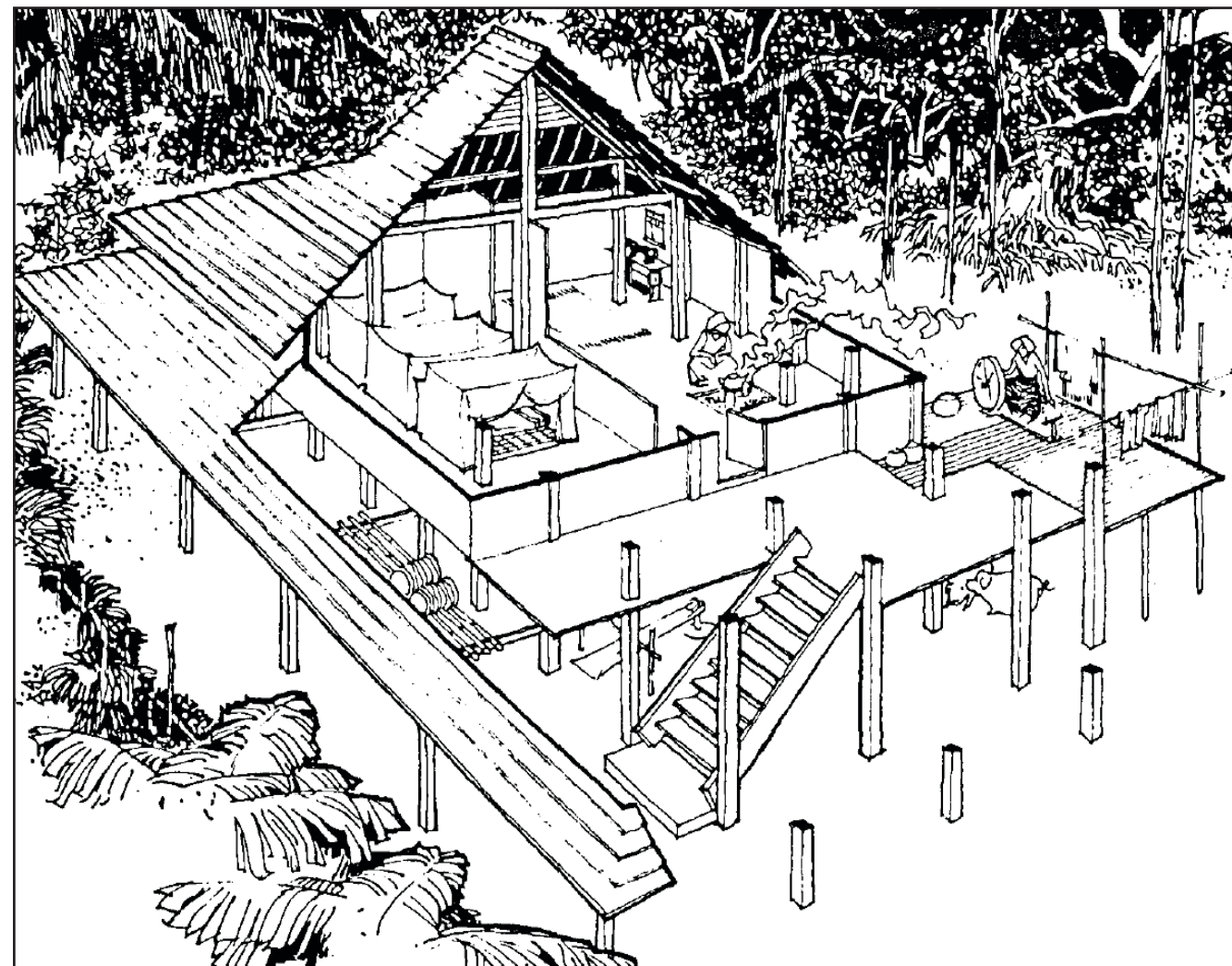
house, with high, sloping roofs and adjoining open-air balcony. Its structure is perfectly suited to the environment as the stilts keep the living quarters above the damp and flood-prone ground plan, snakes, scorpions and other wild creatures. The high, peaked roofs protect the interior from rain and allow for ventilation through a chimney built into the framing.

Aesthetically, the overall shape set against the undulating hills,

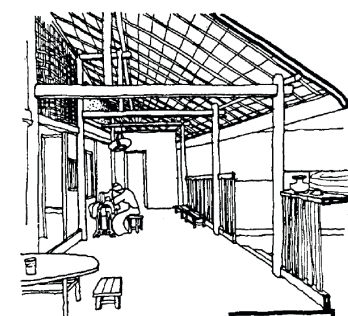
ENVIRONMENT

The vernacular architecture of the Dai People is designed to meld with its environment both in terms of aesthetic and function. The elevated living area as seen in the image to the right means that the first level where work is usually conducted is sheltered from the tropical sun. In addition to this, the almost total lack of solid walls maximizes air circulation throughout the home. This, in conjunction with a chimney to allow hot air to escape, forms a passive cooling system to regulate temperature in Dai houses.

is perfectly harmonious with its background. Essentially the Dai house is an elevated rectangle with roofs like the sides of a triangle. Access is by a staircase at the front entrance. On one end of the home is an open-air balcony, with its own staircase or notched log. People use this area to dry crops, laundry, dyed cloth, and thread.



Cut away of Dai dwelling, Taken from Yunnan Sheng Sheji Yuan 1986



LAYOUT

Within the one-story houses the cooking, sleeping, guests areas and other activities of daily life all take place on the single upper floor. There may also be partitions for the dining and kitchen room, the sleeping quarters of the elders, and a small family shrine. For the rest of the space, at night the family just spreads mattresses and pillows along the floor and all sleep in the same are.

"Dai dwellings, unlike Han dwellings, are open to the surrounding environment, lack solid walls, and are built with little attention to either hierarchy or axuality in their plans. Married children are not expected to live with their parents but to set up separate dwellings."

-Zhu Liangwen, Vernacular Dwellings of the Lijiang Naxi, 84-85



Modern Dai Home, By Jericho Kakaio-Edwards 2015

MODERN VS TRADITIONAL

The adaptation of new materials in Dai villages is far more varied than those of the previous Hani people. As such the following section will stray from the chronological journey of vernacular to modern and will instead rely on side by side comparisons of building methods new and old. In doing so, this section will highlight not only the failures of modern materials, but their various successes as well.

The uses of these materials can be broken down into three categories: Workability, Aesthetic, and Function. Workability refers to replacements or modifications of a material to allow for a more effective construction process. Aesthetic refers to both the success and failure of maintaining the visual aspect of traditional architecture. Finally, Function will be reminiscent of the Hani portion; delving into whether modern materials are hindering or helping the ways in which vernacular materials were supposed to function.

AESTHETIC

In many cases modern adaptations have been subtle substitutes of traditional materials with more regulated and efficient modern ones, hence not only improving life expectancy for the home but maintaining a sense of culture as well. However later in the section we see that this is not always the case.

STRUCTURE

The framing system employed in both modern and traditional Dai architecture has remained mostly unchanged. It is best known as a Galan Chuandou frame, in which a series of mortise and tenon joints work together to form an interlocking matrix. The Dai traditionally built some of the most sophisticated Galan (Bamboo storied) dwellings, although today concrete has started being used to take the place of some of the previously timber columns. However, unlike the Hani people, the Dai do not suffer from earthquakes and thus the concrete only improves the bearing capacity of their structures without the negative implications.

ISSUES

The various ways in which modern materials are used have caused many problems, the most sever being a loss of air flow and hinderance to the passive cooling system that was once so effective.

BUILDING MATERIALS

- Timber
- Bamboo
- Ceramics
- Concrete
- Steel
- Glass



Dai framing with milled wood, By Jericho Kakaio-Edwards 2015

SUCCESSFUL ADAPTATIONS: WORKABILITY

The smaller images above illustrate a shift in Dai roofing materials. Traditional Dai roofs were all finished with wooden shingles. Today these are being replaced by a ceramic model which keeps the same overall look of the building, but offers a more dependable product

which wont need to be replaced as frequently. Plus, the reflective properties of the ceramic tile helps to keep the houses slightly cooler in the tropical climate than their wooden counterpart.

This new application of material is occurring throughout



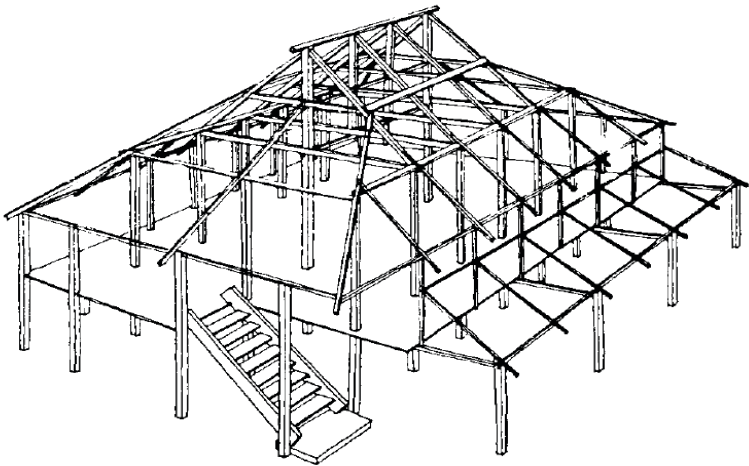
Traditional wooden shingles
By Eugene Geinzer 2013



Ceramic shingles
By Jericho Kakaio 2015

the homes in the village. As stated before, Dai homes rely on a complex network of timber framing as seen in the images above and bellow. The technique is the same as it has always been, yet the material has been brought up to modern standards.

Previously, wood used in construction was sawn by hand using local sources. While this created a relationship between setting and material often lacking in this age of global architecture, it also created inconsistencies of quality and dimension.





Hand Sawn Dai Timber Frame
Mengjinglai Village
Eugene Geinzer 2013



Milled Dai Timber Frame
Mengjinglai Village
Jericho Kakaio-Edwards 2015



Dai village near Menghai, GoKunming.com 1996

FAILED ADAPTATIONS: AESTHETIC

By 2007, the price of Pu'er tea had risen to ten times what it sold for at the start of the millennium. The tea cultivators suddenly found themselves in possession of more cash than they dreamed...and like the newly rich rubber planters, they rushed to spend it on improvements in their material lives.

-Jim Goodman
The Dai Stilted House

Although the use of modern materials in Mengjinglai has largely kept the traditional look and building language of Dai vernacular architecture, that is not always the case. China is not a country which shares the stigma that other nations often associate with copying someone else's style. Dating back to the art of calligraphy, which often involved studying the handwriting of masters and replicating their work for the sake of approving ones own

skill, the practice of repetition and mimicry has been a crucial part of Chinese culture and the continuity of tradition.

As such, when the explosion of wealth from tea came, the first priority seemed to be the production of new, modern houses. So they demolished their traditional stilted houses and erected cement and brick homes that were built on the ground level. Shaped like a box with flat roofs and no open-air



Same village ten years later, GoKunming.com 2006

balconies, they essentially took the design of the immigrant Han houses around the state rubber plantations, who had they themselves made homes by drawing inspiration from western building typologies.

In general, once a few families took the lead in making these new style houses, the rest of the villagers hurried to follow suit. As seen above with the images of Menghai Village, in only a few years villages which

formerly consisted of nothing but traditional stilted wooden houses are fully transformed into villages of nothing but identical concrete boxes.

The issue goes beyond pure aesthetics and runs into function as well. These homes are among the most unfit for a tropical region. The whole logic of traditional Dai construction is jeopardized as "modern" starts to become synonymous with environmentally defunct.



Open chimney with ornamentation around oculus, By Jericho Kakaio-Edwards 2015

FAILED ADAPTATIONS: FUNCTION

As mentioned before, even while preserving a traditional aesthetic modern materials can hinder the function of Dai houses. With the concrete boxes of Menghai nearly all the environmental design choices are abandoned from the raised level to minimize

flooding, to the enclosure of the typically open home. Even while maintaining some of the aesthetics at Mengjinglai, certain advantages are also lost.

As a result of the wide spread use of modern windows in the village, the homes have all



Sealed chimney of Dai home, By Eugene Geinzer 2013



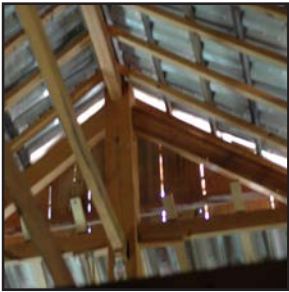
By Jericho Kakaio-Edwards 2015



By Jericho Kakaio-Edwards 2015

abandoned the traditional hinged walls primarily constructed of perforated bamboo screens. Instead, the walls are now made up of heavy, solid timber to support the frames. This causes the same issue as in concrete homes. The absence of screens means that even while the new windows are open, the air flow is drastically reduced compared to the traditional model due to some walls still being solid wood. This sets off a chain reaction of retrofits since less air-flow means many houses in Mengjinglai have had to invest in AC systems. However for AC to work the built-in chimneys which had previously allowed hot air to flow out, also had to be sealed to keep cold air in.

**SUMMARY OF DAI
THEN AND NOW**



FUTURE - PAGE 57

The construction documents in the later sections addressing the folly of modern Dai construction will attempt to include the positive aspects of Dai architecture today while fixing the areas in which it is lacking. Using higher quality standardized building components has proven successful, however ways must be found to use them without hindering the carefully thought out, passive functionality of traditional Dai structures.

WORKABILITY

Many traditional materials have proved valuable, increasing the longevity and quality of a building while also standardizing size and simplifying construction.

AESTHETIC

The aesthetic of homes is left largely up to the families who occupy them. In locations such as Mengjinglai with their culturally focused building code, tradition is at least partially preserved. Yet this is not always the case.

FUNCTION

It is when materials attempt to reach beyond the boundaries of simple replacement for a better quality that Dai homes begin to suffer. Often when trying to add modern luxuries all of the environmental design aspects of vernacular Dai construction are undermined. This is usually in the form of reduced air flow and increased probability for flood damage, both of which are very detrimental in a tropical climate.

TIBETAN

Tibetan prayer flags entering Hongpo Village
By Jericho Kakaio-Edwards 2015





Google Earth Pro

SITE LOCATION
HONGPO VILLAGE

Yunnan’s 110,000 or so Tibetans are mostly concentrated in Deqin Tibetan Autonomous Prefecture, along the southeastern boarder of the Qinghai-Tibetan Plateau. The Tibetan culture in Yunnan has all the characteristics of highland Tibetan culture further west.

The location for the third set of construction details, which will address thermal massing at high elevations, will be Hongpo Village. The Tibetan people in this village reflect a trend which has spread among Tibetan architecture in general: the implementation of glass and steel to essentially let their home do for people what a green house does for plants. Unlike the other two sections on the Dai and Hani people, this use of modern materials is largely successful and had been adopted by Tibetans across Yunnan, allowing them to make use of an overabundance of sunlight which is present despite the cold temperatures. As such, rather than criticism and alternatives, this section will focus on the improvement of an already functional system.

LOCATION

Located in northwestern Yunnan the village is 8 km from Shangri-la city proper and situated in a frigid yet dry valley at an elevation of 9022 ft. The area has a frost season of 5-6 months and even during warm months can still be buffeted by cold winds

DEMOGRAPHIC

The population of Hongpo is roughly 2130 people, and 400 households. All villagers belong to the Tibetan nationality and nearly 90% of villagers over 60 are illiterate, although younger generations typically receive at least a high school education.

ECONOMY

The average annual income is approximately 5,000 RMB (780 USD). Agricultural production consists of barley, wheat, and potatoes although most harvests only meet villager’s needs with little extra for export as a feasible means of income.

RELIGION

The villagers follow Tibetan Buddhism. With each family keeping a shrine in the home, usually located in the upper and rear most portion. This is often considered the most important place in Chinese homes, contrary to western architecture where the front is the most glamorous.



Main road in Hongpo Village, By Jericho Kakaio-Edwards 2015

CONTACT WITH MODERNITY

Since the county the village resides in was renamed Shangri-la after the mythical city in an attempt to attract tourists, visitation to northern Yunnan has grown exponentially during the warmer months. However, a large part of this tourism is Eco-related and focused

on conservation, as such the culture and environment are still relatively well preserved. However, this same increased access with the outside world may be how materials and construction methods much more advanced than shown



By Jericho Kakaio-Edwards
2015



By Jericho Kakaio-Edwards
2015



Home behind basketball court, By Jericho Kakaio-Edwards 2015

previously in the book, spread so rapidly through Tibetan households. The difficulty of obtaining these materials should prove a hinderance to their utilization. However, this is clearly not the case as they can be found in some form of retrofit in almost all of the homes in Hongpo Village.

VERNACULAR ARCHITECTURE



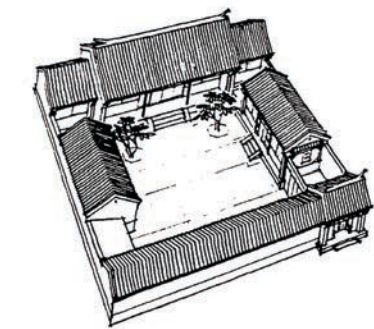
Front of a stand-alone Tibetan home, By Eugene Geinzer 2013

GENERAL INFORMATION

Traditionally Tibetan houses are large, solid constructions of timber and rammed earth. Each is two to three stories tall with walls covered in stucco before being whitewashed. Roofs vary between flat and pitched, with shingles on them weighted down with stone to combat the high winds.

The Tibetan homes typically follow the layout of courtyard houses, meaning one home has multiple structures and a

gate, all of which face towards a central enclosed courtyard. As such multiple generations are able to live here. Tradition dictated the homes follow a hierarchy, with the senior most family member or head of household taking residence in the back, most central home. When children marry they and their spouse would move into the adjacent side structures.

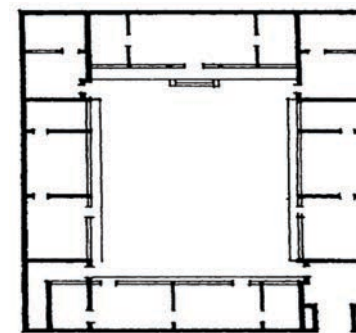


LAYOUT

Tibetan housing complexes usually involve 2-3 adjacent houses, and the massive structures are typically three stories as seen to the left. The ground floor was traditionally reserved for animal stables while the family resided on the second story much like the Dai mentioned previously. This level included the kitchen, bedrooms, and shrine room. The upper most floor was set aside for drying grains and storing other goods. In the smaller side houses, two stories in the norm. With livestock already in the main house, the hierarchy shifts down and the family lives on the ground level.



Back of Tibetan housing complex, By Jericho Kakaio-Edwards 2015



THERMAL MASS

Tibetan homes are massive in every facet of their design from the footprint to the structure. The rear and side exterior walls are made up of thick masonry, starting wide at the bottom of and slowly tapering towards the top to reduce the weight. The thickness of the walls keep out the low temperatures by causing heat to take longer to escape the home. Kitchens in the houses serve as primitive

but effective heating systems. Utilizing a fire pit on a lower floor, the ceiling directly above is removed creating multi-height spaces for heat to travel through the house before escaping through windows on the third story. Even the open air balcony can be sealed off from the rest of the residence with solid timber if need be, as is shown in the image of the front of the home.



Glass and steel courtyard shelter, Eugene Geinzer 2013

MODERN ADAPTATION

The Tibetan people have taken a slightly more nuanced approach to the implementation of modern materials than the other groups, for although it could be seen as aesthetically invasive, it does not greatly inhibit the way the home was designed to function in its given environment.

In fact, depending on the time of day it can even enhance the performance of the home by functioning in the same way as a green house. The glass helps with passively heating the home during the day, both in terms of keeping out the winds and by increasing the amount of heat retained inside. However, when night falls much is still left to be desired as that same heat is lost at an unacceptable rate.

AESTHETIC

In almost all cases the glass structures break the traditional aesthetic on Tibetan homes, however that can be argued both as invasive or as an interesting juxtaposition between new and old. Regardless of the argument, the system is flexible enough that the extent to which it changes the appearance of a home is left in the hands of the owner and how they want to implement it.

STRUCTURE

The structure for these sometimes massive spans of steel in glass is a truss system. These steel trusses are an extension of the frames themselves, welded together into a single cohesive piece and mounted onto their existing houses.

ISSUES

The Tibetan use of steel and glass is one of the few successful adaptations. However it can still be improved. Although the homes are heated quickly during the day by sunlight, the connections between home and modern structure is lacking. In addition, the glass is poorly insulated, meaning that the new interior spaces it forms are often uncomfortably cold.

BUILDING MATERIALS

- Timber
- Masonry
- Stucco
- Steel
- Glass



Interior of modern Tibetan home's first floor, By Andra Grijia 2014



By Andra Grijia 2014



By Andra Grijia 2014

GREEN HOUSE: SUCCESSES

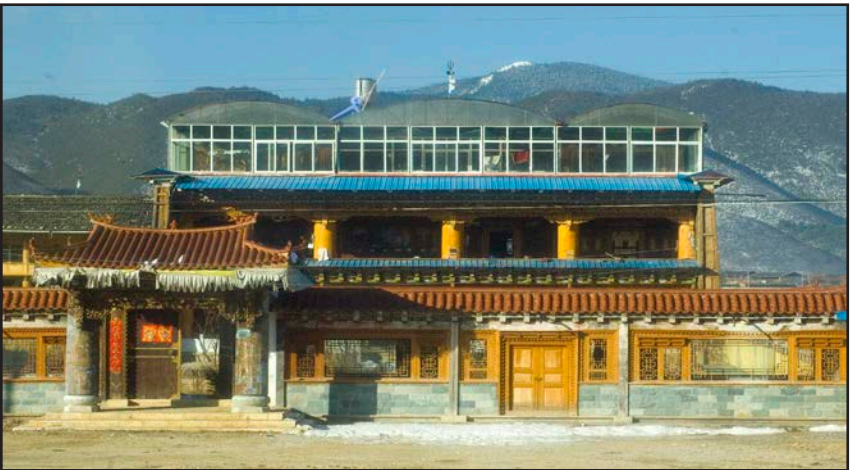
Whether the glass was first used to simply keep the cold winds at bay while maintaining visibility, or to function the same way a green house would, the design is successful in both aspects.

Aside from it being able to keep

out the wind, the structure also traps sunlight. As with a green house, the short-wave infrared light from the sun is able to enter the glass and warm the home. However, as the light reflects off of the surfaces within, it slows, wavelength lengthening. As such, not all of it is able to escape

back out through the glass. A portion of sunlight ends up bounding off the glass windows to the inside, repeating the process. This forms a passive means of heating the home which compliments the thick masonry walls and their innate ability to retain heat.

The structure is also not open to the air outside meaning that heat can not escape via convection. However the connections via house and glass as seen in the images above are far from airtight and can still be improved.



Rooftop Glass Structure, Eugene Geinzer 2013



Interior of Tibetan “Green House Structure” second floor, By Andra Grija

GREEN HOUSE: IMPROVEMENTS

As stated in the previous section the process of convection, or heat loss via contact with a colder substance, relies on the heat within the home coming into contact with the outside air. This is something the structures could potentially prevent very well, however the current connections used between the homes and their steel retrofit are lacking. Many of the window panels are operable so fresh air

would not be an issue. A more effective way of binding new and old would only mean that these same operable windows could allow the owner greater control over his home’s airflow with less worry of hot air constantly leaking through cracks.

This slippage of heat is worse at night. Glass, especially single pane glass, is good at trapping sunlight but has a poor thermal mass, the result is that at night heat escapes the glass safe heaven at a rapid rate, bringing

up the final issue.

The last problem is a blessing in disguise. The open air balconies were ultimately separate from the actual living space of the home. However, the glass has expanded the livable area to the balconies and even first floors as seen above and on the previous page. The issue is that the glass is the only addition thus these new living areas have no defence against the heat loss.

SUMMARY OF TIBET THEN AND NOW



FUTURE - PAGE 65

The construction documents in the later sections addressing the potential improvement of Tibetan green house structures, will explore the potential for better connections between the new and old materials while factoring in the skills required to build such a structure. The goal is to find a balance which minimizes unintentional loss of hot air but that the people would still be able to learn to build. Other improvements to be explored are how to improve the thermal mass of glass, and how to solve the issue of insulation for the new living spaces.

SUCCESSSES

This innovative use of modern materials utilizes the access sunlight in the region which is present even in the typically cold temperatures. It effectively keeps out the wind while absorbing and trapping heat to improve the homes passive heating system.

IMPROVEMENTS

The system works very well at trapping sunlight and therefore repeatedly heating the home. However, it falls short in terms of trapping hot air due to gaps in the connections, and in terms of trapping heat itself due to the low thermal mass of glass. Not only this, but because more of the home is now warm during the day, daily living areas have extended to outside the traditional bounds into places which were not designed to be warm. Placed outside the solid timber with only glass separating them from the elements, these areas are not habitable at night. Of course they could be primarily daytime areas, but that is not ideal if they are to become mainstay characteristics of Tibetan homes in the future.

FUTURE

Construction Methods for a More Holistic Architecture

This section explores the issues brought about by modern materials which were touched upon in previous pages, and offers alternatives to replace or repair them. With an understanding of how the three cultures used to build, as well as how they build now, we can begin to explore construction techniques which may help their buildings in the future.

The section follows the established order of Hani, Dai, and Tibetan, and aims to provide each group with building methods which would better incorporate modern materials into their architecture. Some of the techniques to follow have been tested at varying locations around the world while some are more theoretical. However, all of them are applicable and, more importantly, usable by the three cultures considering requisite skill level, available materials, and practicality.

Newly built timber and masonry home in Mushan Village
By Jericho Kakaio-Edwards 2015





HANI CONSTRUCTION

Building for Seismic Activity

As established, the main issue with modern Hani construction is the new found preference for stone and earth based masonry as the primary structure. In traditional construction similar masonry units were only used for non-load bearing walls while the actual structural support for buildings came from a timber framing system. However today even the columns have been replaced with concrete.

It is commonly found in Zuofu village that concrete columns are placed at intervals in the masonry wall, essentially resulting in concrete framing with masonry in fill. Similar methods are employed elsewhere in the world, the difference being that concrete at Zuofu is not reinforced. This makes the technique vastly less effective as it relies on masonry units being held in place by a more ductile framework. Unreinforced concrete is far from ductile, as it is steel rebar embedded within reinforced concrete which gives it its name, and that characteristic.

Therefore, the following pages will discuss way in which the people of Zuofu may be able to enforce their masonry techniques with materials local to them. Since wood is a more seismically viable building material, the section will use that as the focus of the construction methods, including techniques such as bamboo as a replacement for rebar or the potential for concrete columns in the in fill system to be replaced with timber counterparts.

Homes on the edge of Hani rice terraces

By Jericho Kakaio-Edwards 2015



TIMBER FRAMED MASONRY WALLS



Masonry reinforcing techniques being used in Pakistan, Haiti, Peru, and Indonesia respectively
From National Geographic

Taq Construction From India to China

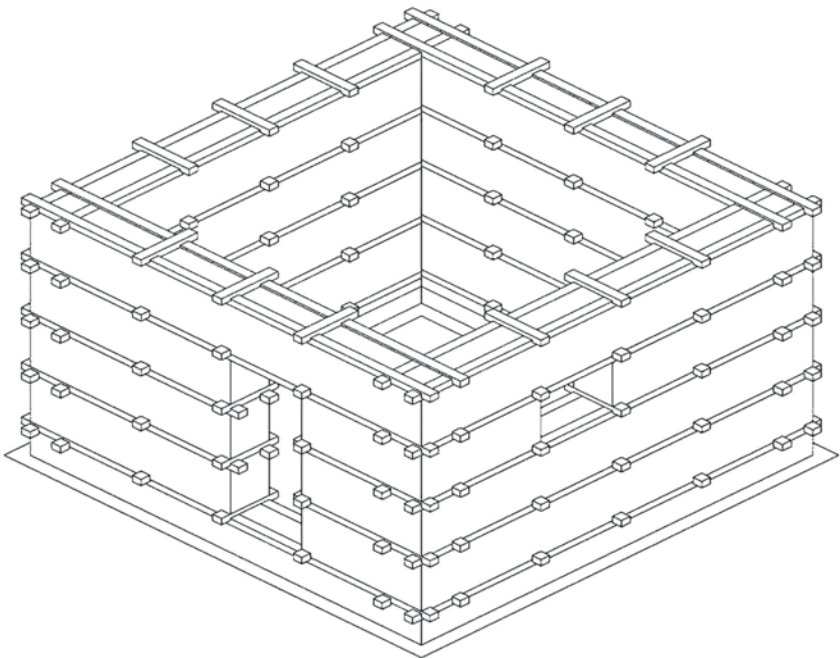
Taq as its called in Srinagar, bhatar in Pakistan, is a traditional construction system which was once common in these regions. It designates a timber laced masonry building which can be several floors high yet still able to withstand earthquake thanks to the combined use of masonry and wood. This makes the system particularly compatible with the needs of Hani architecture given the desire for larger homes while still using readily available stone and wood.

The masonry is reinforced with horizontal ladder-like timber

lacings embedded at intervals throughout the wall vertically; the distance can vary but the plinth, floors and lintels levels are particularly important. The reason for this is because at the floor level, the timber floor joists are compressed between two sets of the ladder-like timber lacings. This can be seen in the diagram on the bottom of the following page. This essentially allows the wooden beams to tie the floors of the structure together with the walls. In terms of seismic performance, although the walls are brittle the flexible timber lacings are the key to the earthquake resistance.

The flexibility of the wooden lacings allows the building components to have slight displacements. In doing this, the friction within the various parts of the building system, allows a good amount of the energy induced by an earthquake to dissipate, preventing the walls from collapsing.

The integration of Taq masonry techniques into Hani architecture would be a simple addition which could provide vast improvements to the current poorly reinforced masonry. Simple, is the curial term as an overly complex method



Wooden bands in Taq construction system, By Dominic Dowling

would lessen the practicality and defeat the purpose.

As seen in the two images above, homes of Taq are easily able to reach the heights of current Hani homes and greater, while the timber lacings are able to minimize if not totally prevent collapses. In the upper image, taken after the 2005 Kashmir earthquake, the unreinforced masonry front wall of a 4 story building collapsed, while the wall above was able to bridge over the damage, holding the side walls together and thus preventing the complete failure of the building.

To improve the earthquake resistance of Hani homes

even further, the current unreinforced concrete columns can also be replaced with timber counterparts. The Hani adaptation would use horizontal timber rings at the floor and lintel levels instead of constant intervals throughout the wall. Doing so braces the most important levels while making it easier to work in the ladder-like reinforcement. Once the wooden columns are in place, they can then be connected to the ring beam and by proxy floor using joinery common in Hani architecture. Such a method would reinforce the entire structure vertically while increasing the ratio of wood to masonry.



Tiber band stopping collapse
By Randolph Langenbach



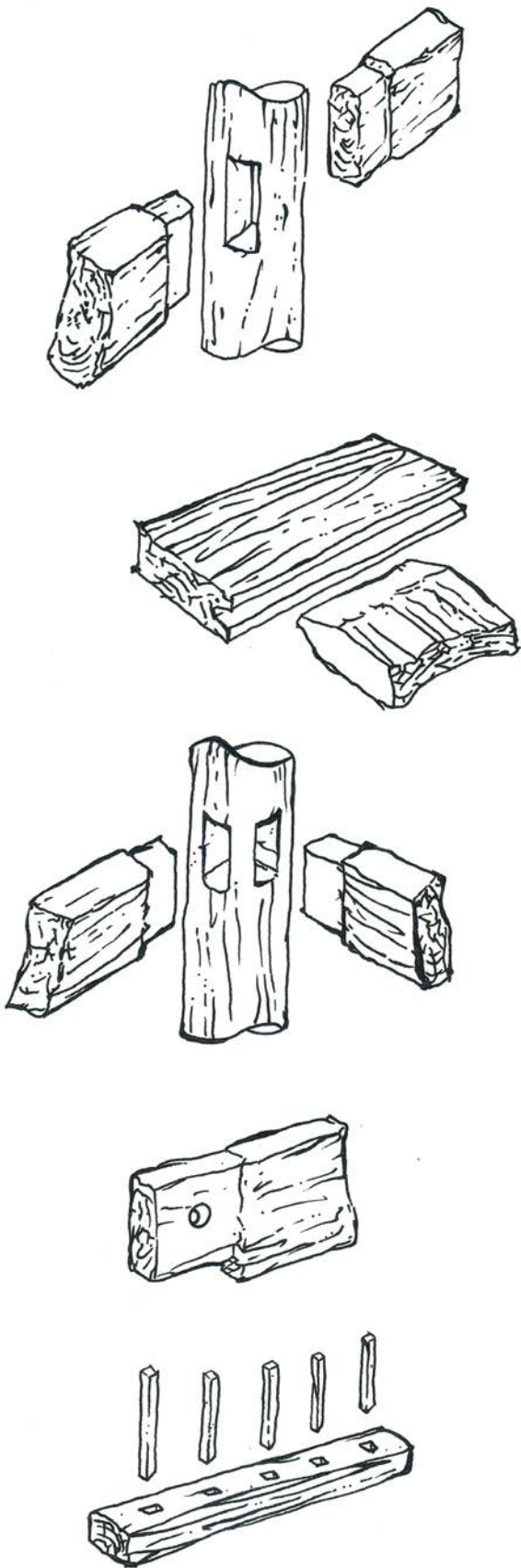
Four story house of taq
By Randolph Langenbach

“Perhaps the greatest advantage gained from [timber] runners is that they impart ductility to an otherwise very brittle structure.”

-N. Gosain and A.S. Arya,
A Report on Anantnag Earthquake on February 20th, 1967



Taq Construction Diagram
By Randolph Langenbach

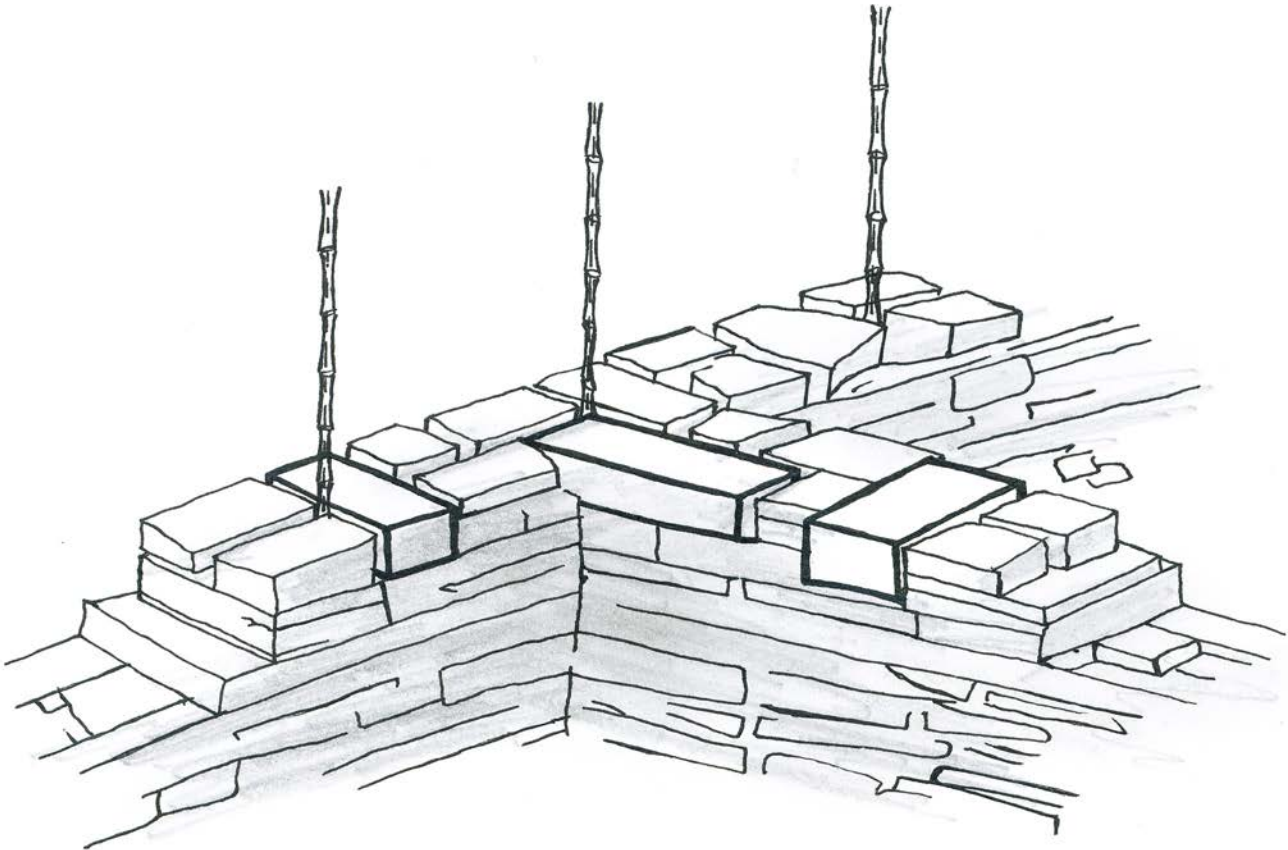


**Practicality
Of Use**

Shown in the image to left are numerous common types of Chinese joinery which can be found around the country, many of which have been demonstrated by the Hani in their traditional architecture. These techniques can serve as the primary form of connection between the timber columns and the beams which support the floor, with the first and last connection being of particular importance.

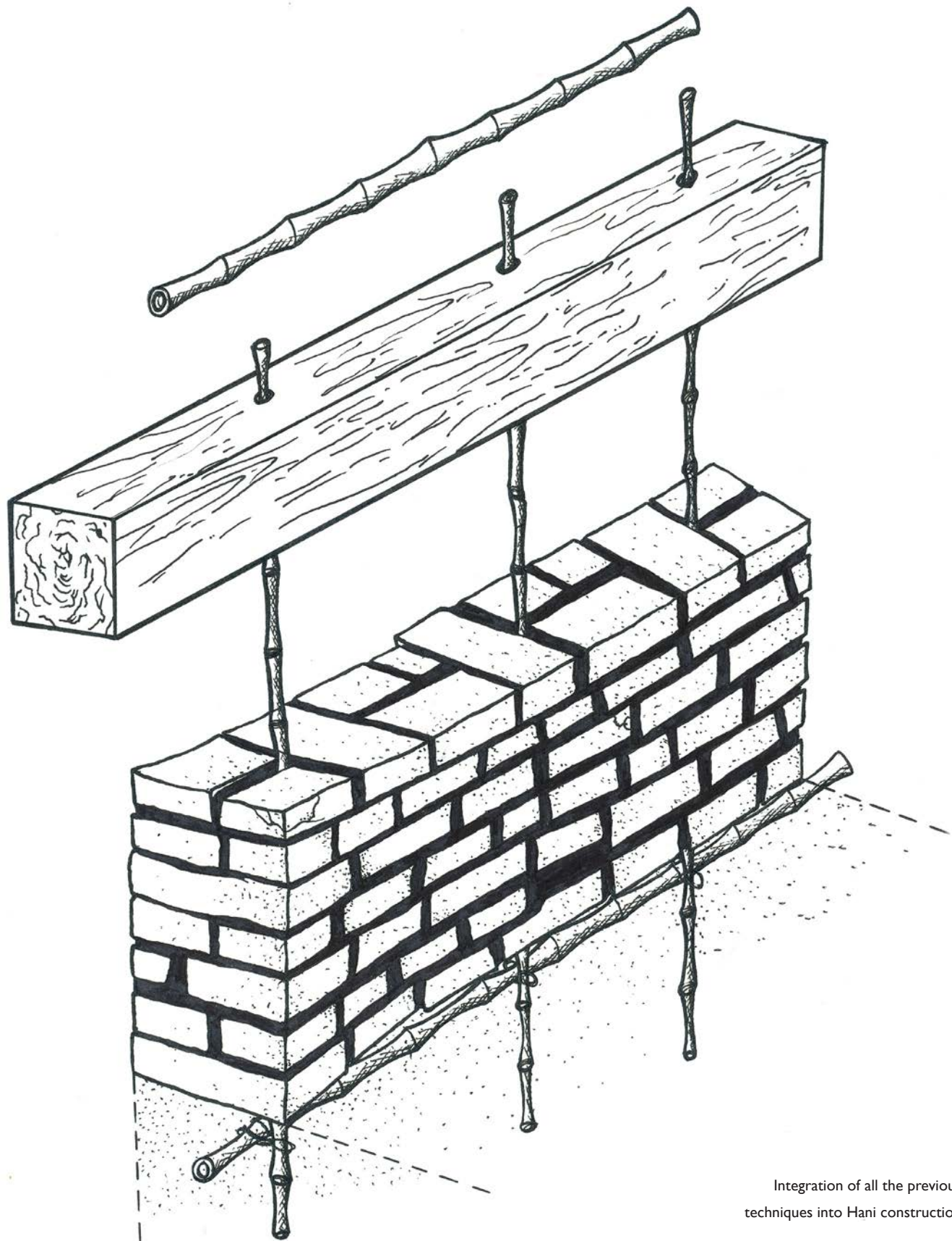
The timber can be local as the people of the village have proven to have access to the material, evident by its presence in their exiting architecture. The bricks being used in the masonry walls can remain consistent with what is currently available as well.

In terms of skills required for construction, improving the seismic resilience of their homes would not require serious relearning of complex techniques, but could be grasped fairly easily as they are simple additions to the exiting building methods.



**Building With Masonry
and Bamboo**

In addition to the horizontal lacing system of Taq construction, other techniques have the potential to strengthen the masonry of Hani Construction even further: Bamboo reinforcement and proper masonry wall construction. Through stones are when masonry units transverse the walls depth as shown above. Their use is key as the masonry must span the entire thickness of the wall to stabilize it. The next method is bamboo reinforcement. In 1992, full-size models of a one-room building were tested on a shake table (PUCP/CIID 1995). The results showed cane reinforcement, combined with a solid ring beam, can prevent wall separation at the corners, even in the case of a severe earthquake. The reinforcement proved effective in preventing building collapse. Many adobe houses reinforced with cane have been built in Peru and El Salvador.



Integration of all the previous techniques into Hani construction

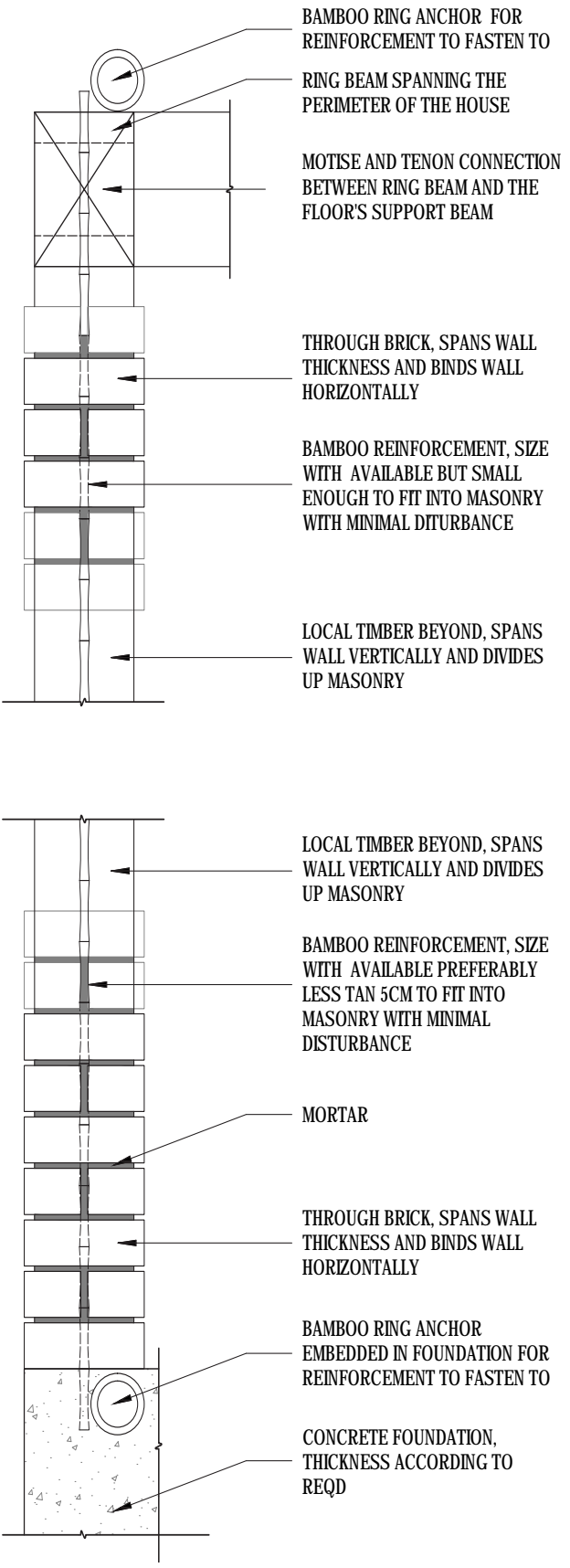
An Architecture of Yesterday and Tomorrow: Hani

Shown in the images to both sides is the culmination of the aforementioned seismic building techniques combined with Hani construction methods. The bamboo reinforcing will be placed first. Fixed at the bottom to a bamboo ring anchor embedded in the foundation. This will enable the reinforcing to hold its position and fulfill its purpose.

The brick, as mentioned previously, will remain the same as currently being used. However, care must be taken to ensure that some of them act as “through” bricks and transverse the entire thickness of the wall. They will be placed around the bamboo reinforcement and bonded together with mortar.

When a lintel and upper floor level is reached, a timber ring beam will be placed to partition the building similar to those in Taq construction. The bamboo reinforcement can then run through the beam using the last method of Chinese joinery shown on the previous page. Once through, the bamboo reinforcement can again be fixed to another bamboo ring anchor, thus binding the wall together from top to bottom.

Floor and columns can also be connected to the timber ring beam using the mortise and tennon joint (first joint on previous page) or a simpler method.





DAI CONSTRUCTION

Building for Tropical Climates

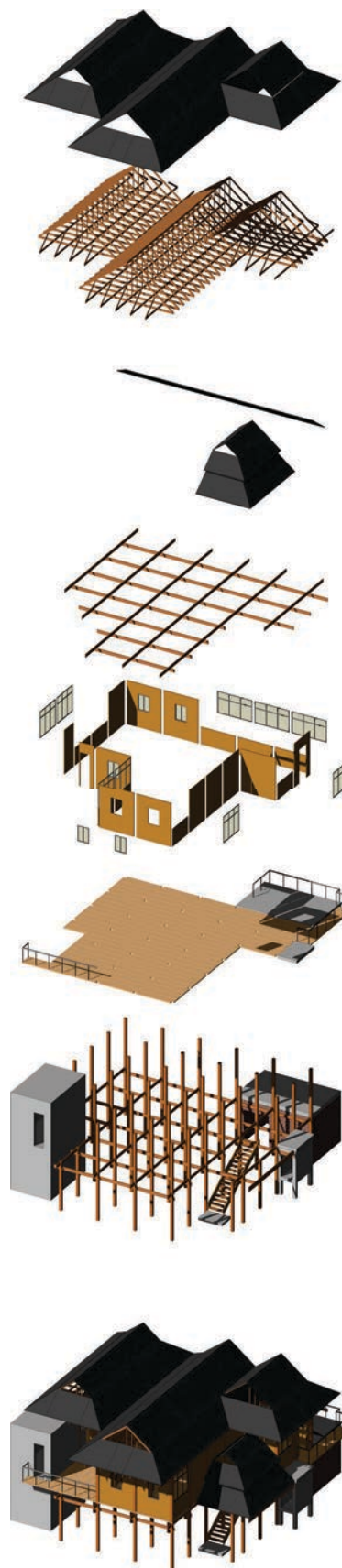
As established, the main concern with current Dai construction revolves around a lack of air circulation. Although some replacements of materials with more modern and regulated versions have shown benefits in terms of quality and longevity, the replacement of bamboo screens with glass windows is not among them.

Glass windows not only allow more sunlight to enter the home and raise the internal temperature, but their weight required more structurally sound walls to support them. This means that the walls of Dai houses which were typically bamboo screens allowing air to pass freely, had to be replaced with solid timber to support the windows, and walls without windows are still solid to match. Thus even with windows open the flow of air into the space is still drastically reduced. As such many Dai household have opted to buy air conditioning units to get their houses down to a comfortable temperature. Yet for the AC units to be effective, the roof chimney which was originally designed to let hot air rise out, was also sealed with wood.

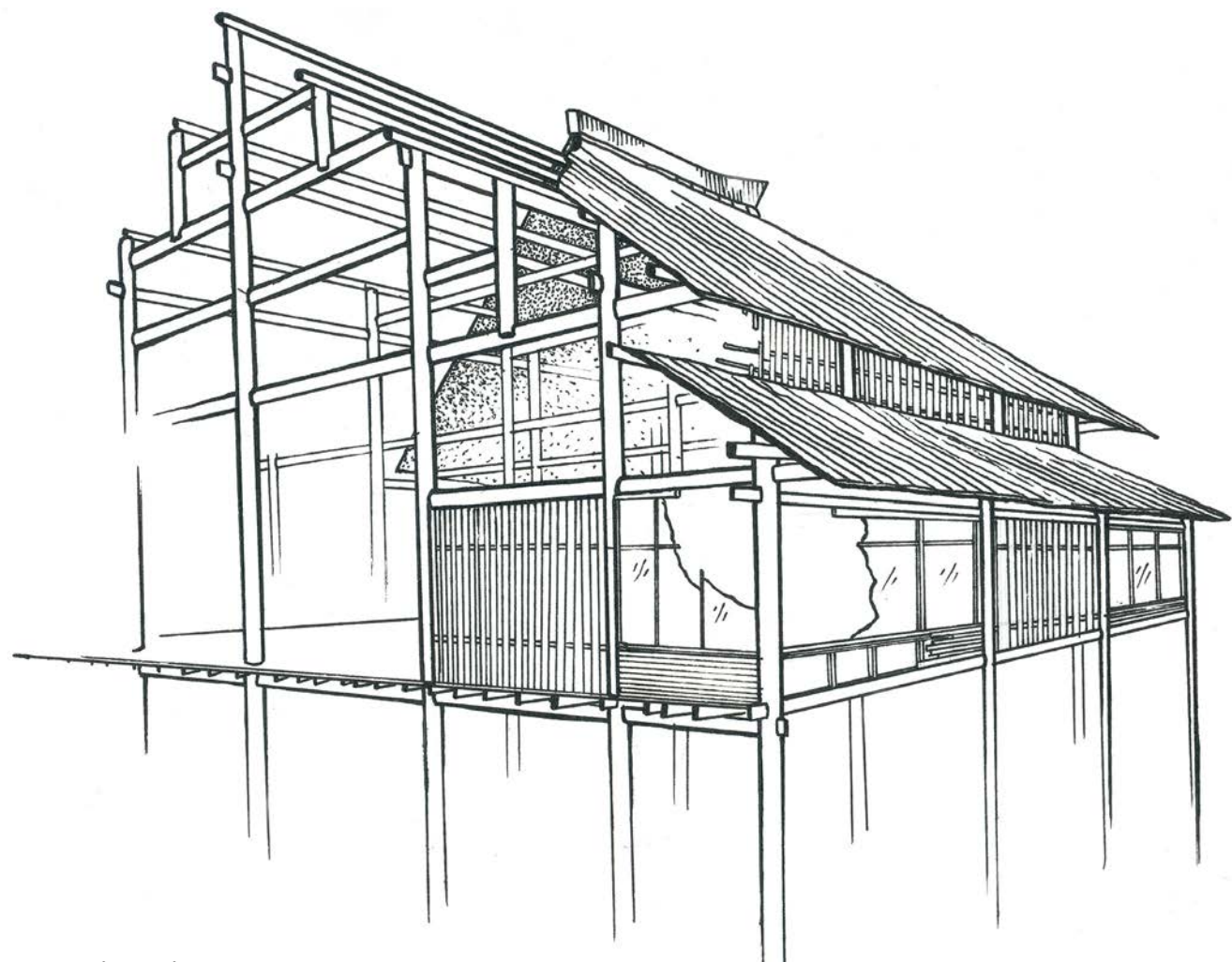
Therefore, the following methods will investigate ways in which more air can pass through the home, while maintaining the windows and a visual relationship to the outside. Such methods will include a hybrid wall framing system to allow both screen and glass windows, as well as the modification of the home's roof system based on the concept which made the roof chimney so effective.

Modern Dai Home in Mengjinglai Village

By Jericho Kakaio-Edwards 2015



BAMBOO SCREENS AND ROOF MODIFICATIONS



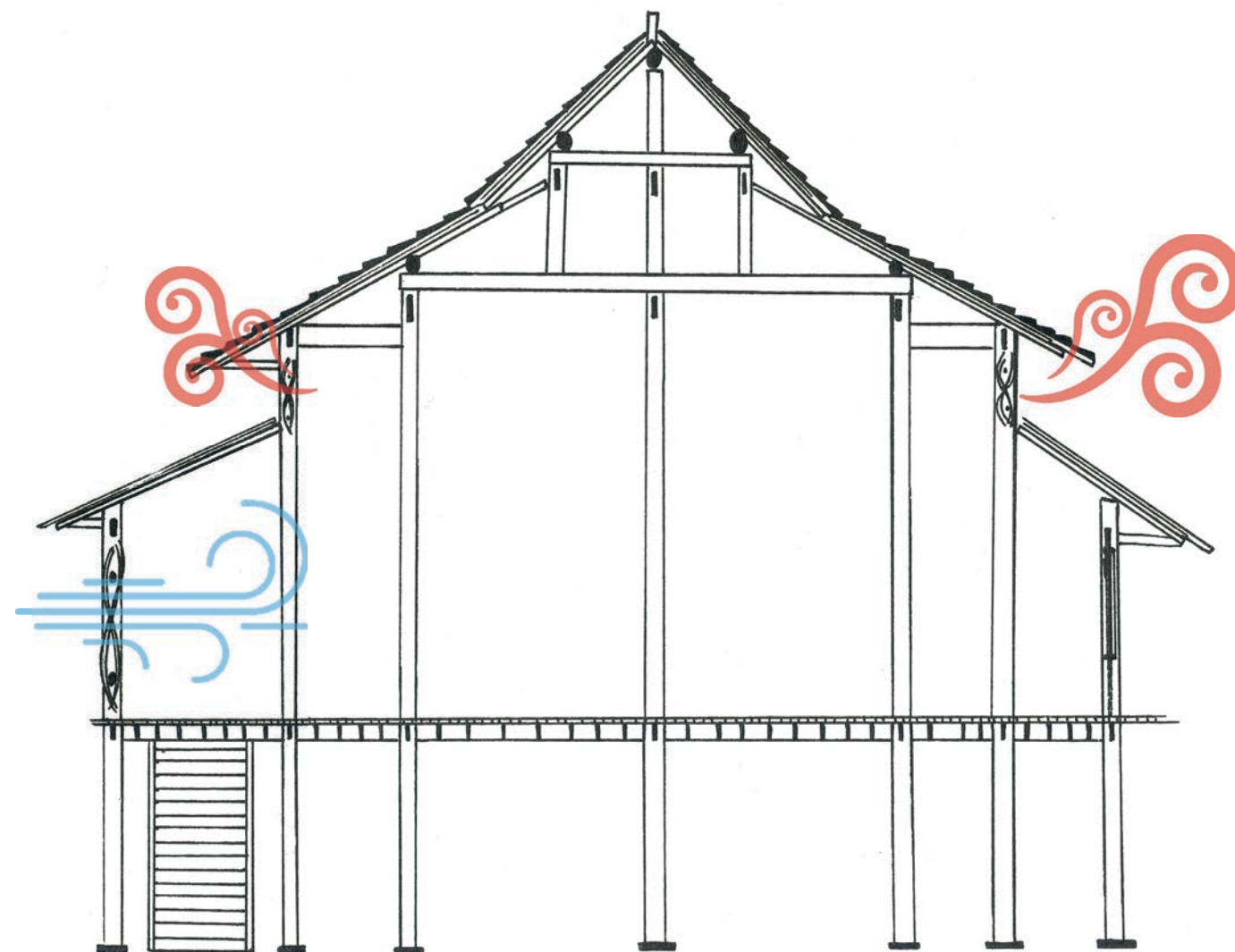
Improving Air Circulation: Bamboo

It is clear that the introduction of modern glass windows has caused numerous issues which have reduced the effectiveness of the vernacular cooling system. However not all the implications were negative, namely a visual connection to the outside world and an amount of natural lighting which was lacking in traditional Dai homes. As such the windows should not be scraped completely.

Yet not all walls in Dai homes have windows, and those which do not provide an opportunity for the reintroduction of traditional screens.

As mentioned earlier window walls and solid walls cut off an enormous amount of air flowing throughout the home. However each bay (column to column) is essentially filled with only one

wall type. This means that, as shown in the image above, the solid wall bays can be replaced with bamboo screens without compromising the structure of the window wall bays. The windows are not floor to ceiling, and therefore require solid wood walls underneath them to support their weight. Those must stay but the all the other solid walls can be replaced.



Improving Air Circulation: Roof System

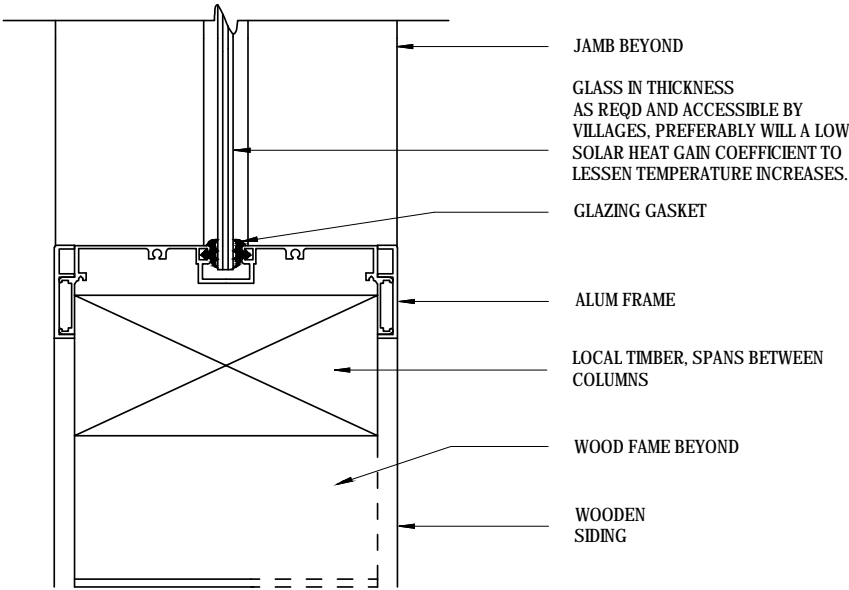
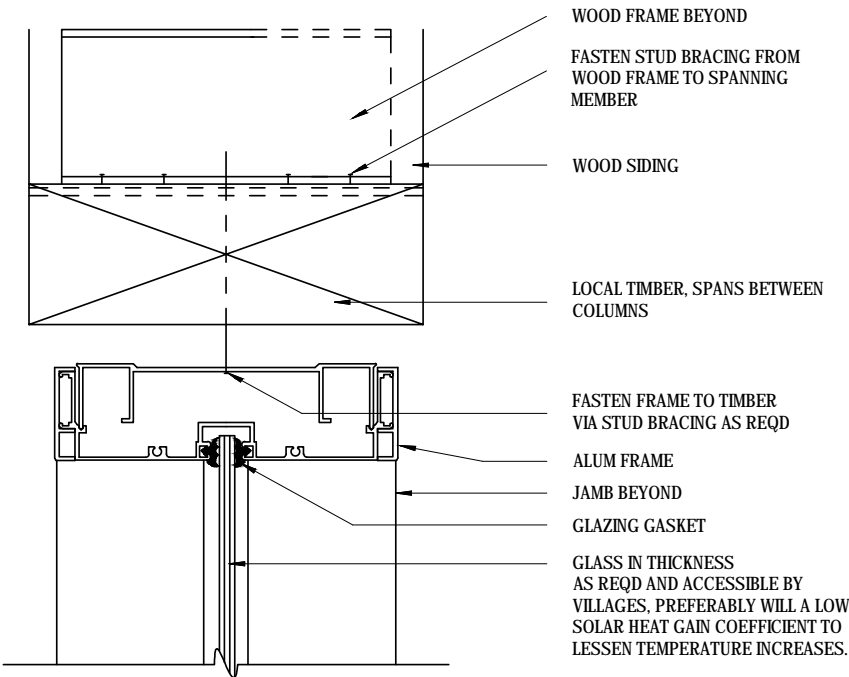
Replacing the solid walls which are not supporting windows adds a fair amount of air circulation back into the space. However another additional, albeit more drastic, method is to modify the framing system for the roof.

Dai architecture already makes use of various roof levels, accomplished through their intricate network of roof beams.

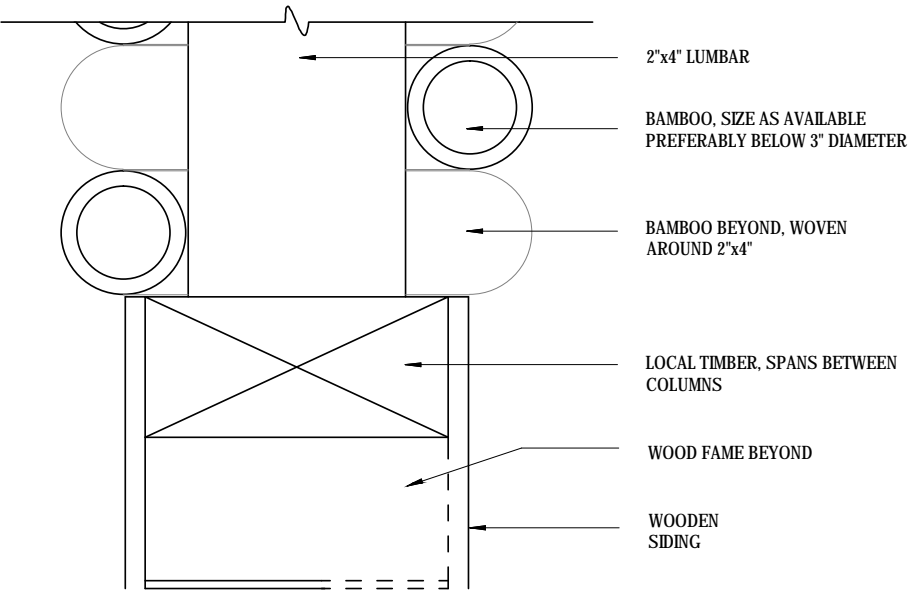
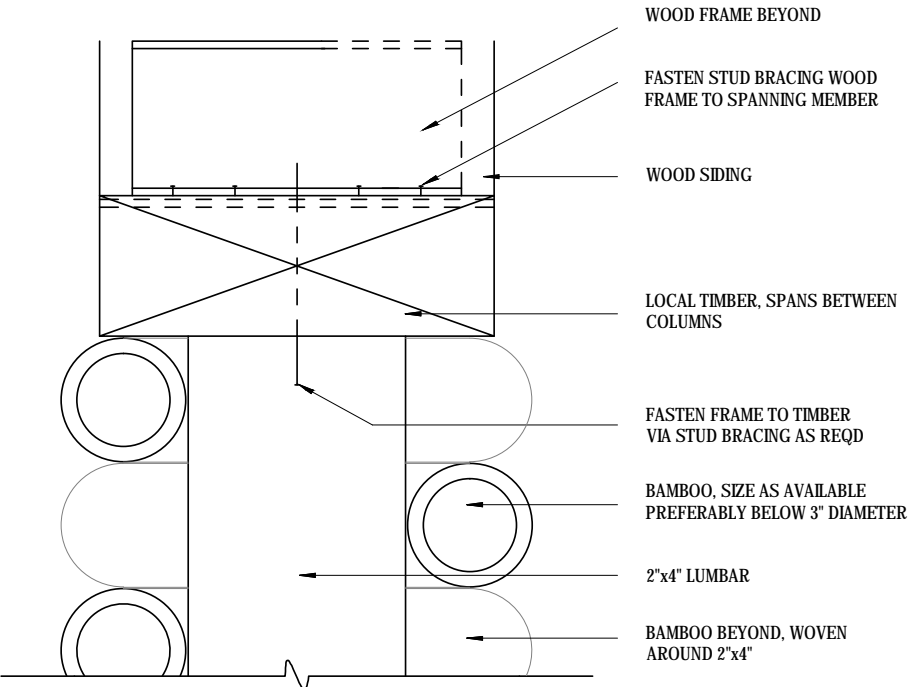
However, if this multi-level roofing concept was pushed a bit further by raising the top level a few feet, clearance would be gained between that level and the level below. This space could then be filled with bamboo screens to essentially create a clearstory. However unlike traditional clearstories which allow sunlight in, it would allow hot air to out. Instead of a single chimney for air

to escape through, you would have the entire perimeter of the home.

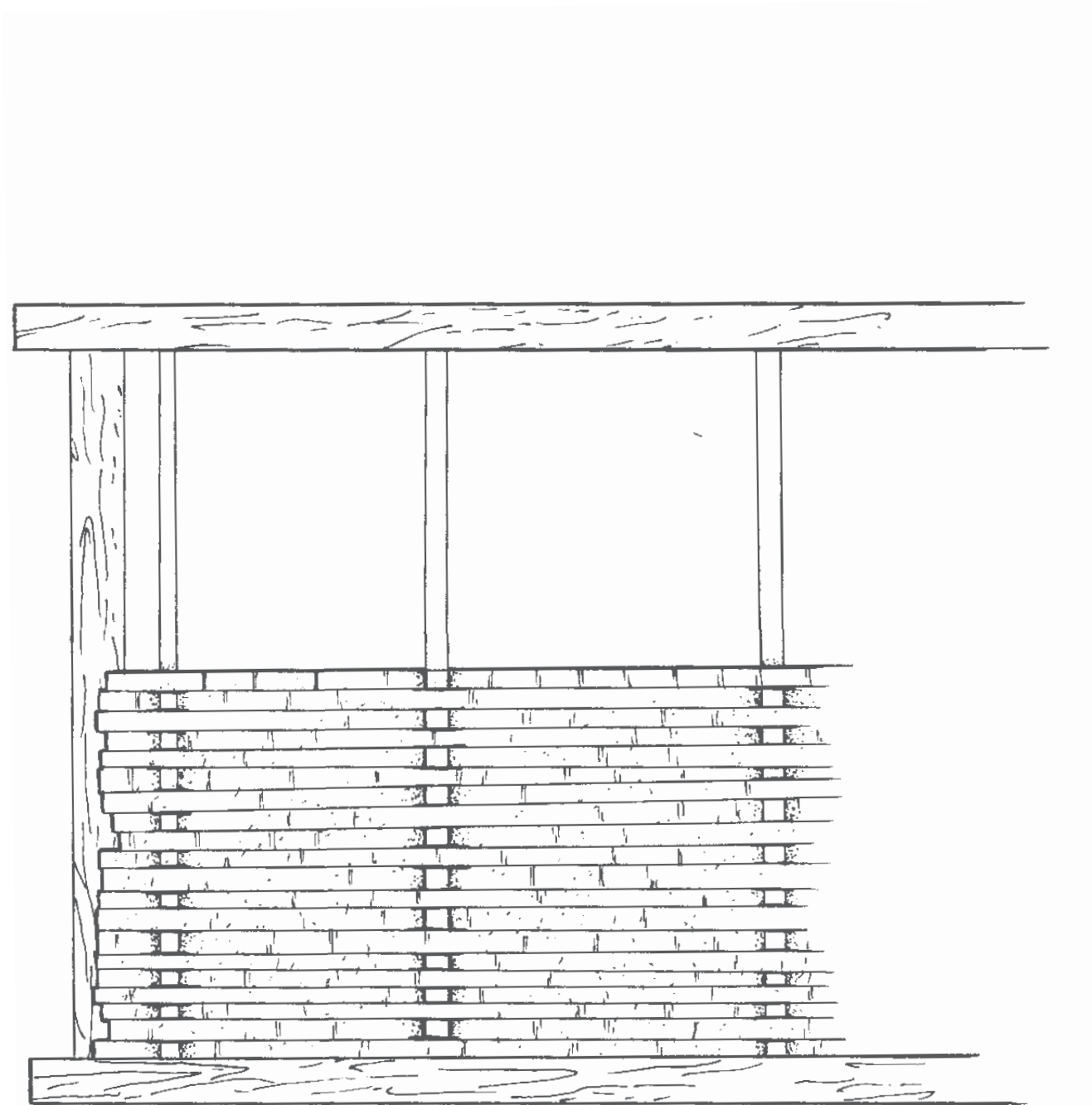
By changing the framing system a little you gain massive benefits, and for the previously mentioned replacement of solid walls with screen walls no modification to the existing structure is needed at all. A side by side comparison can be seen on the next page.



Construction detail of a Dai home's wall framing with modern windows



Construction detail of a bamboo screen fitting into the frame previously allotted to glass windows



Assembly sketch of Dai bamboo screens in existing timber framework

An Architecture of Yesterday and Tomorrow: DAI

Shown in the images to both sides are the structure and aesthetic of the traditional bamboo screen which would be reimplemented into Dai building technology. As mentioned previously, the introduction of modern windows allowed for more solar heat to seep into the home, and the addition of solid walls means that even with all windows open, air flow is still reduced in comparison to traditional homes.

However the walls of modern dai homes are engineered to bear the weight of these new windows, windows much heavier than bamboo screens. This means the screens can be reintroduced in places with little to no modification of the structural system. All of the walls which are currently solid could be have their finishes removed and replaced with porous screens instead.

For a more drastic change, one likely only applicable to future homes and not suitable as a retrofit, would be to change the roofing structure. As stated earlier in the paper the chimneys present in modern Dai homes have been sealed to allow AC to cool the home without that cold air to escape. However by modifying the framing to form a bamboo screen clearstory, the concept of the chimney could be expanded and its function improved.

This increase in air circulation could help the homes return to the traditional levels and render AC unnecessary altogether. However, with some of the walls remaining windows, their lack of airflow made up by the clearstory, the new homes would have natural lighting and views out to the surroundings not present in classic Dai architecture.



Bamboo Screen, By Jericho Kakaio-Edwards



TIBETAN CONSTRUCTION

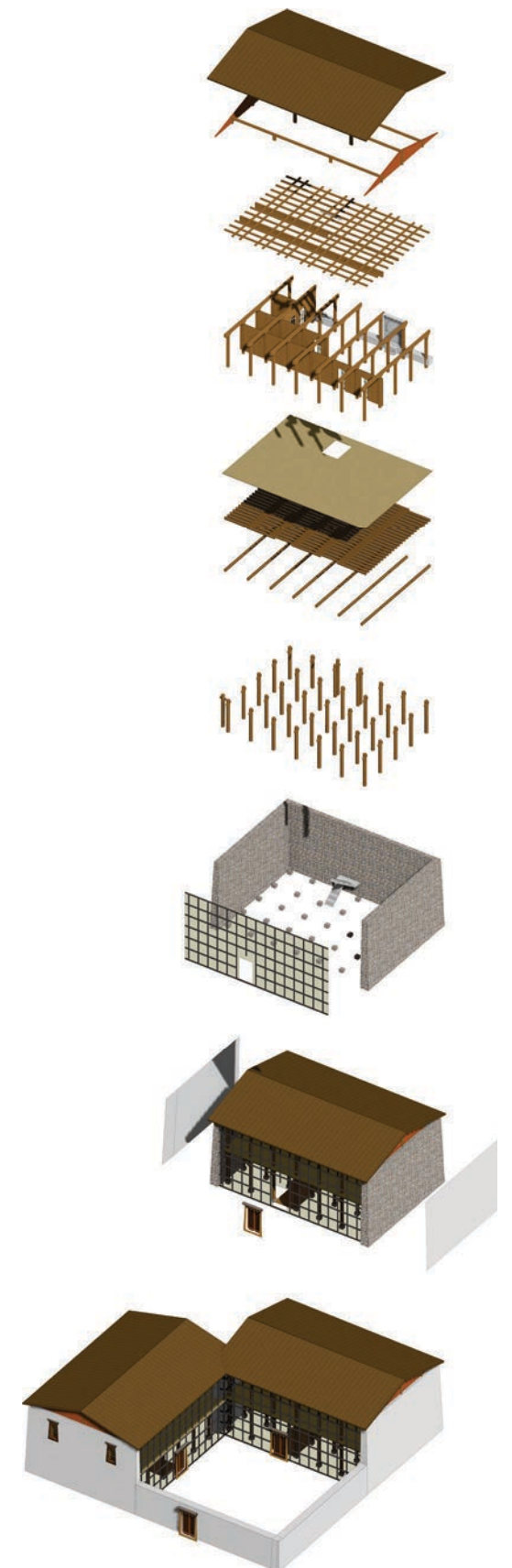
Building for Cold Climates

As established, the “green house” system employed in modern Tibetan architecture is versatile and effective means of heating the home through sunlight which is magnified and trapped as it passes through the glass. However, this method is far from perfect and can still be improved upon.

Although the system is effective at heating the home, it does poorly in terms of retaining that heat. Glass, especially single pane glass used here, has a low thermal mass meaning heat can escape through it. The connections between the older structure and the new retrofit are also full of gaps. Therefore although part of the infrared radiation is trapped and the home is repeatedly heated, the heat itself as well as the hot air is constantly being released. This is not so much an issue during the day as continuous heating and continuous heat loss reach a semi-comfortable middle ground, but as night falls and the passive heat from the sun leaves, the effects become far more noticeable. This is especially true in areas which were previously outdoor spaces, but are now interior living areas due to the new glass walls.

As such, this section will focus on increasing the thermal mass of the glass addition either through the implementation of multiple glass layers and an air gap, or solid operable walls behind the glass to be closed at night, preventing heat from escaping. Potential improvement for connections will also be explore.

Basketball Game in Hongpo Village
By Jericho Kakaio-Edwards 2015



PARTITION WALLS AND INTERIOR BALCONY SPACE



Cut through 3d model of Tibetan home, By Jericho Kakaio-Edwards 2016

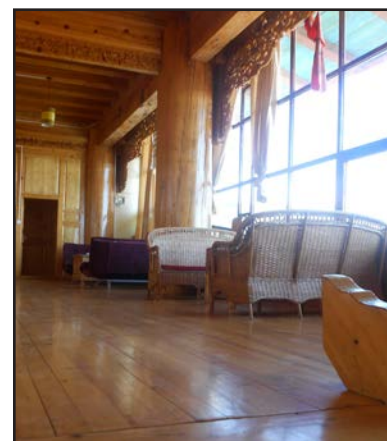
Improving Thermal Mass: Partition Walls

Seen above is a 3D model highlighting the previously exterior balcony space which has been made into an interior area thanks to the glass retrofit.

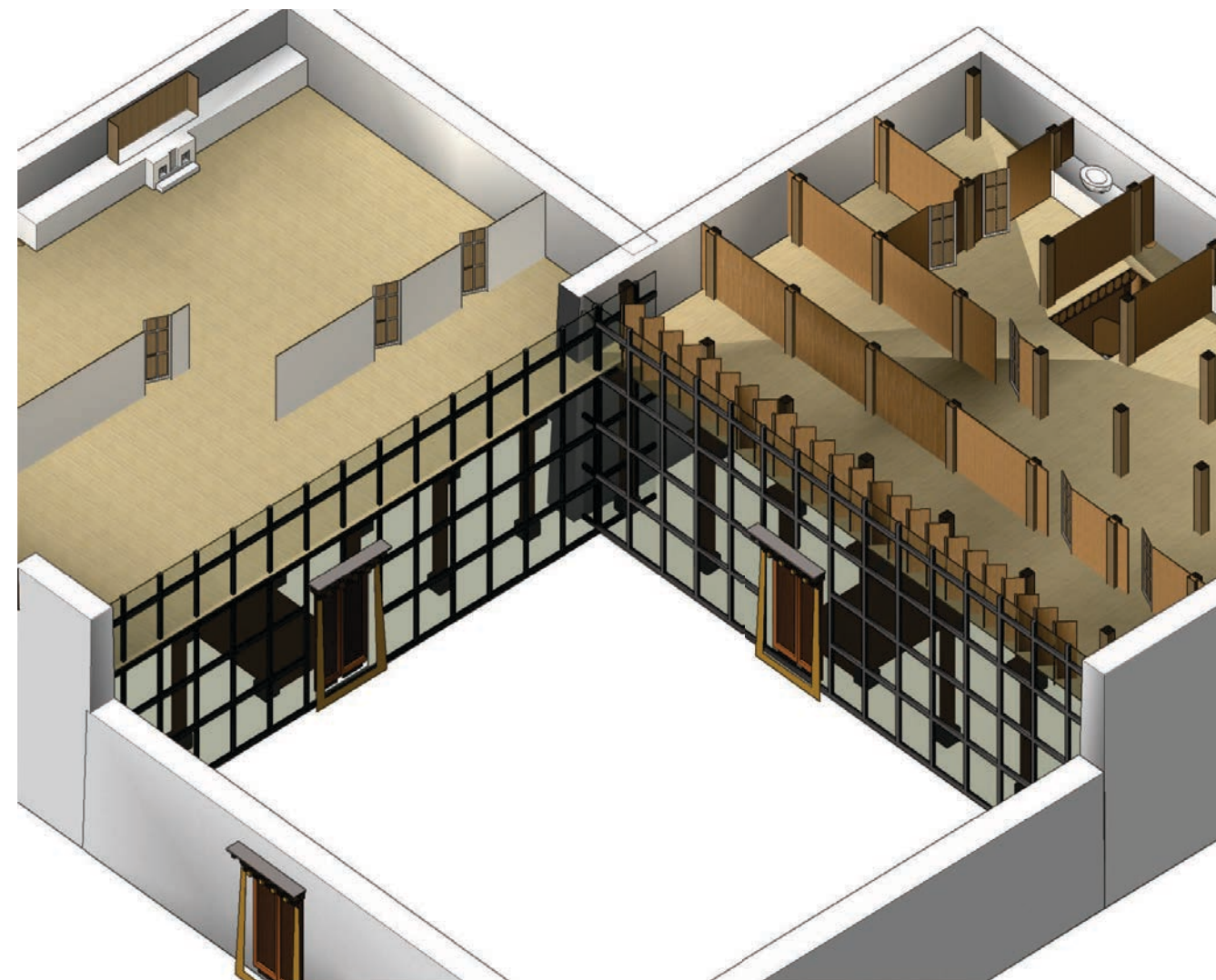
The temperature would not be an issue if the space was still treated as exterior, however as seen in the image to the right the space is now fully considered a living space. The problem, as

previously established, is that the glass is unable to always maintain a comfortable temperature with the limited insulation provided by single pane glass windows.

However, by adding rudimentary wooden partition walls which could open or closed depending on the users wishes, greater thermal mass and temperature control would be gained.



Interior balcony, By Andra Grijja 2014



Cut through 3d model of Tibetan home, By Jericho Kakaio-Edwards 2016

Partition Wall Construction

The partition walls must be kept simple to ensure that their construction is practical for everyone and thus viable in the isolated village locations.

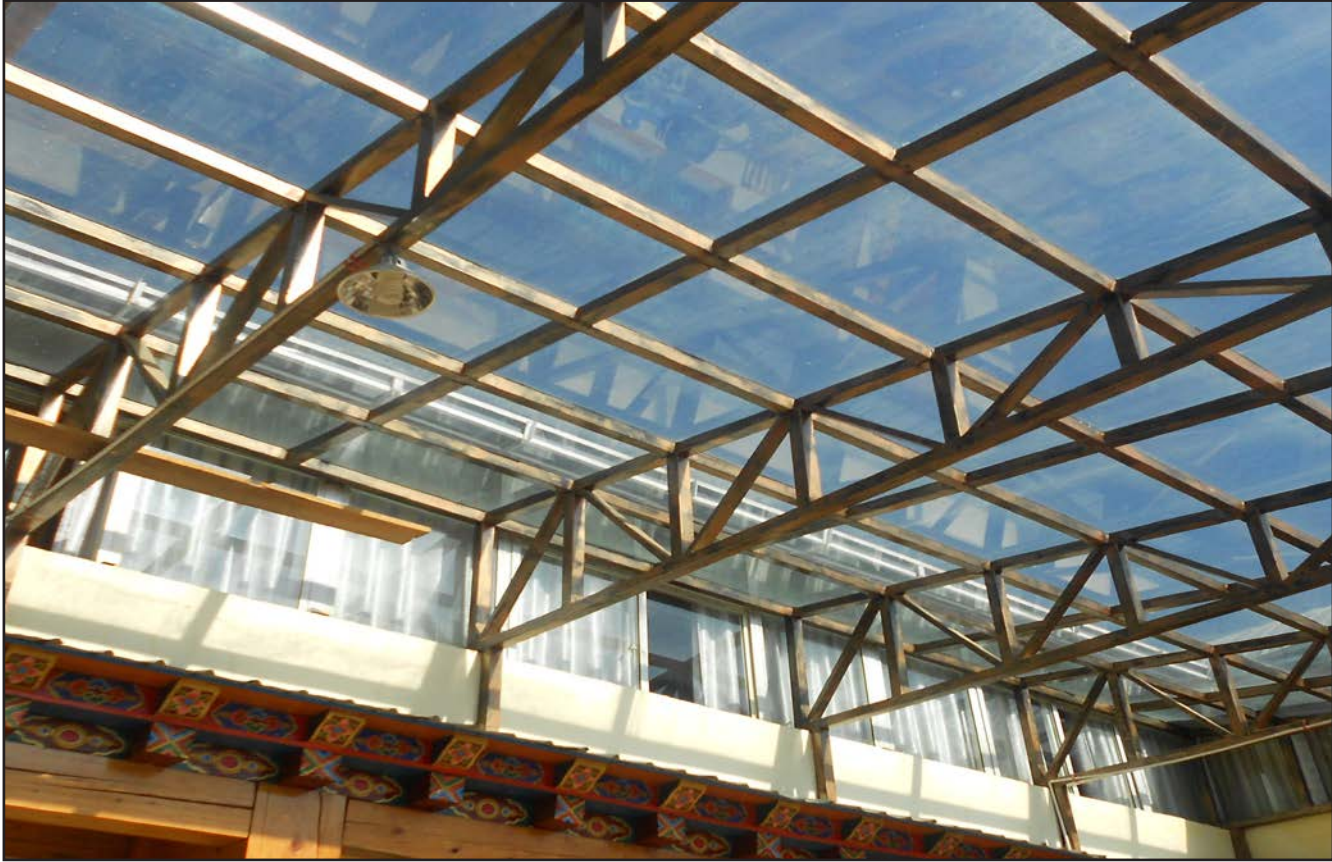
As shown in the image to the right, the walls would be single panes of wood, with their thickness and height left up to the home owner and the dimensions of their house. Rudimentary extrusions

can be carved out of the total board or added later depending on preference, these protrusions on the top and bottom would fit into holes on the floor and ceiling allowing the wall to pivot.

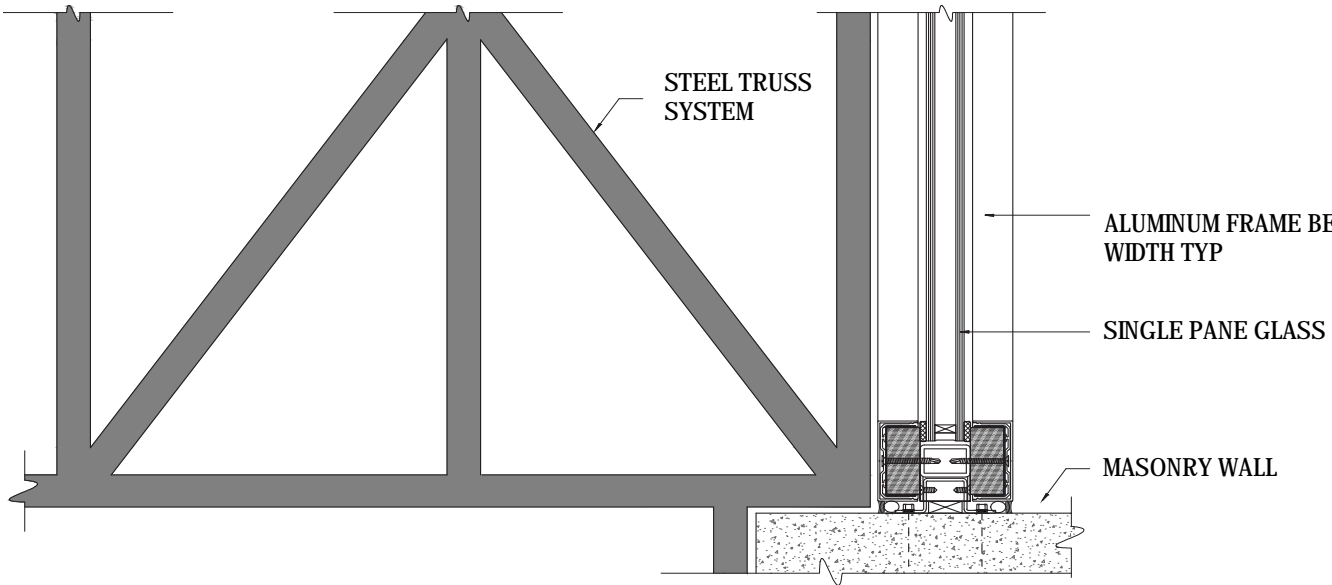
Wood has a higher thermal mass than glass, so while the walls are closed you are essentially making the total exterior thicker and lowering heat transfer.



CONNECTIONS STEEL AND GLASS RETROFIT



Connection between steel frames and original structure, By Andra Grijja 2014



Connections Between New and Old

As seen to the left the connection between the glass and steel truss addition and the original structure is little to nonexistent, appearing to simply be set down atop the structure and leaving air gaps constantly between frame and wall surface be it the clearstory shown in the image to the left or other masonry sections of the home.

These trusses span from one end of the home to another meaning that they are relatively stable without any attachment, acting like a well fitting lid. However that does not mean they keep the warm air inside the home from escaping, counteracting the passive heating nature of the glass itself which traps sunlight.

This problem is fairly easy to remedy depending on the nature of the assembly. In some cases the more complex pieces are prefabricated while in others the whole frame is welded together on site from individual pieces of tube steel. If it is prefabricated then that limits the potential to modify dimensions. However, if it is cut to size to fit the home then the steel pieces should be extended to run into solid surfaces. Take the image above, the truss should not stop vertically in the middle of the existing window but should instead run up to the roof level. This would allow for a proper insulated connection.

Potential Use of Foam

The potential for this connection is dependent on the people's ability to obtain similar products, however the Tibetans have proven themselves more adept at obtaining and utilizing modern materials than the other groups, and thus it will be included regardless of its feasibility.

If insulation is desired beyond a simple flush connection between new and old by extending the frames to create a tighter fit, Low Expansion Foam is also commonly used in more developed regions to insulate the area around window frames. This foam, seen below, could be used to fill the minor gaps between the steel frame and original structure which are bound to be present even if the frames are fitted better.



Foam sealant, From Energystar.gov

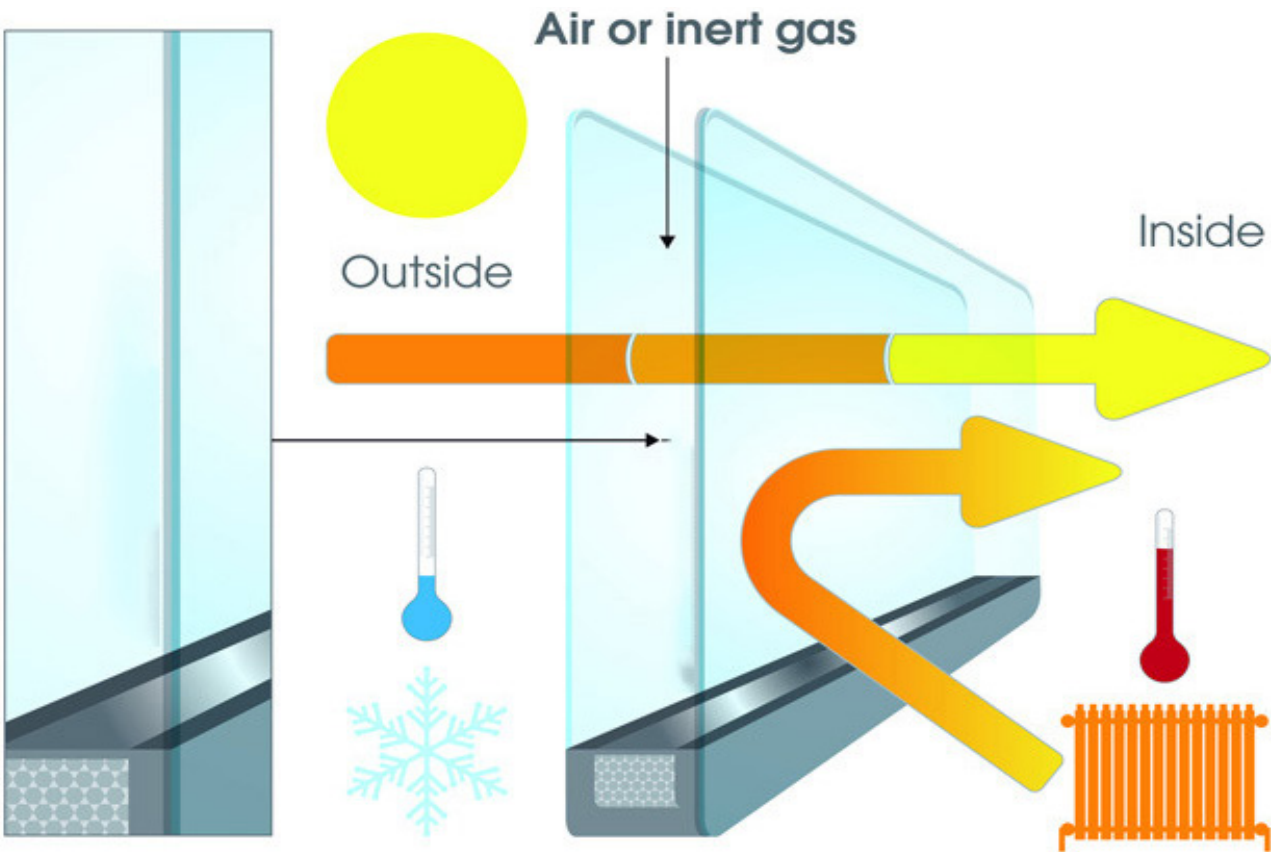
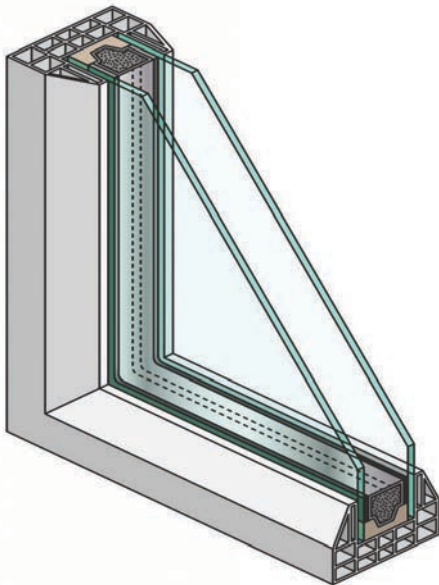


Diagram of Double Pane Windows, By Mybuilder.com

Double Pane Glass

The final factor in the issue of the “green house” type retrofit not function to its maximum potential is the use of single pane windows. While single pane windows are easily made and readily available, they are one of the easiest and often first things to be replaced in more developed areas when trying to increase a buildings energy efficiency.

This is because as shown above, the extra pane of glass and the air gab in between them decrease temperature transfer between the interior and exterior of a home. In the case of Tibetan architecture, using multi-pane glass windows instead of the current single pane ones is the quickest was to increase the effectiveness of the glass and steel structures they have begun using.



An Architecture of Yesterday and Tomorrow:TIBETAN

As mentioned at the start of the section on Tibetan architecture, of the three peoples their use of modern materials has been the most effective, practical, and widely accepted among the group as a crucial part of their current architecture.

As such, rather than completely modify their use of modern materials, the system only needed to be improved to reach its full potential. To improve upon the glass curtain wall’s insulation qualities partition walls could be added to existing structures, enabling the user to lose the walls and increase the thickness of the exterior and the thermal mass as a result. For new building, the glass being used should have two or more panes, giving insulation to the glass itself and helping it trap heat indoors.

Finally, the frames themselves should be made as flush with the wall as possible rather than haphazardly resting against them. Once this is done, if further insulation is desired and provided the village’s ability to obtain materials, low expansion foam can also be used to fill the minor remaining gaps.



Steel frames, By Andra Grija 2014

This paper has explored the nature of construction for three peoples in three different stages: past, present, and potential future. In some the use of modern materials was innovative and highly suitable for the environment, while in others it was misguided with negative effects on the crucial systems of their vernacular architecture. However all of them were valuable in their own right. Situated in unique climates and faced with dynamic environments the groups highlighted here might stand apart from each other, but together they cover a plethora of issues which are common throughout Yunnan.

Yunnan is home to not just three, but 25 ethnic minorities who each face a period of transition as globalization slowly brings foreign influence into their isolated homelands. 25 groups of people who have the chance to understand modern construction of simply mimic it and hope for the best.

CONCLUSION

The purpose of this study was not only to highlight the triumphs and follies of construction methods for a select three groups, but to select those groups whose issues were diverse enough to form a basic understanding of proper construction applicable throughout all of Yunnan. Yunnan is one of China's most diverse provinces in terms of people, climate, and biodiversity. It's architecture should be the same. It should not be fated to mimic the concrete structures so often found in more developed regions, but should be guided so that it not only accepts the benefits modernity can offer, but that it remains a colorful tapestry representative of the people



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Zuofu Village



Mengjinglai Village



Hongpo Village

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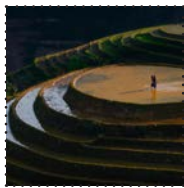
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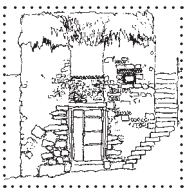
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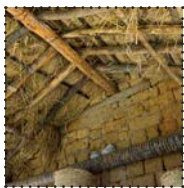
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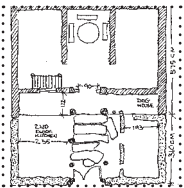
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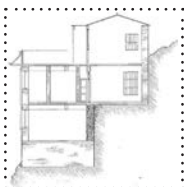
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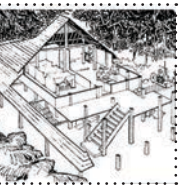
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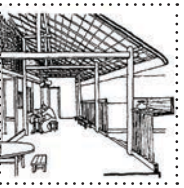
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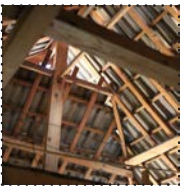
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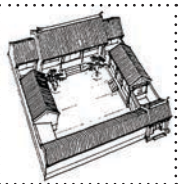
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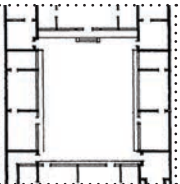
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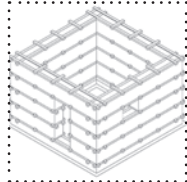
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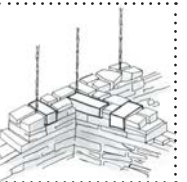
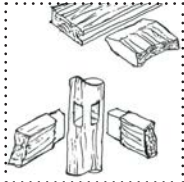


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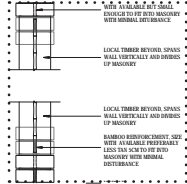
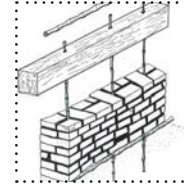


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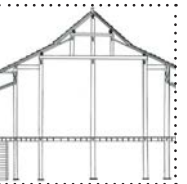
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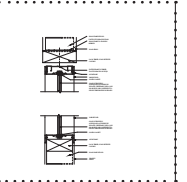
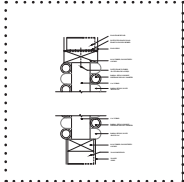
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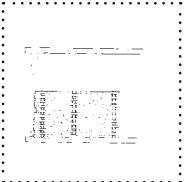


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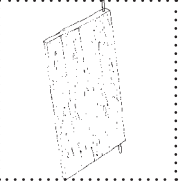
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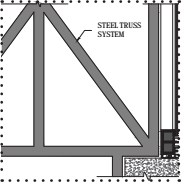
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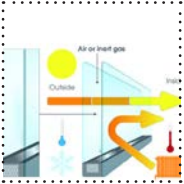


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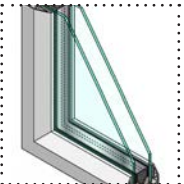


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